Third Five-Year Review Report

for

Eagle Mine Superfund Site
CERCLIS ID: COD081961518

Minturn
Eagle County, Colorado

September 2008

PREPARED BY:

US Environmental Protection Agency Region 8
Denver, Colorado

Approved by: Date:

for Carol L. Campbell
Assistant Regional Administrator
Office of Ecosystem Protection
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9/30/08

Third Five-Year Review Report

Table of Contents

Tables

Figures

Attachments

List of Acronyms

Ac	Acute
ARARs	Applicable or Relevant and Appropriate Requirements
BMC	Battle Mountain Corporation
BRA	Baseline risk assessment
CBS	CBS Operations, Inc.
CDPHE	Colorado Department of Public Health and Environment
CD/RAP	Consent Decree/Remedial Action Plan
CD/SOW	Consent Decree/Statement of Work
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
Ch	Chronic
CMP	Compliance Monitoring Plan
COC	Contaminants of concern
CTP	Consolidated Tailing Pile
cy	Cubic yards
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentration
ESD	Explanation of Significant Differences
gpm	gallons per minute
HMWMD	Hazardous Materials and Waste Management Division of the CDPHE
IC	Institutional Control
IMP	Inspection & Maintenance Plan
mg/Kg	milligrams per kilogram
mg/L	milligrams per liter
MSL	Mean Sea Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
NTP	New Tailing Pile
O&M	Operation & Maintenance
OM&M	Operation, Maintenance & Monitoring
OTP	Old Tailing Pile
OU1	Operable Unit 1
OU2	Operable Unit 2
PCBs	Polychlorinated Biphenyls
pH	Measure of acidity (low pH) or alkalinity (high pH)
PRP	Potentially Responsible Party
ppm	Parts per million
PSCOR	Preliminary Site Close Out Report
RAP	Remedial Action Plan
RAO	Remedial Action Objective

RBC	Risk-based Concentration
RD/RA	Remedial Design/ Remedial Action
RfD	Reference Dose
RI/FS	Remedial Investigation/ Feasibility Study
ROD	Record of Decision
RPM	Remedial Project Manager
Site	Eagle Mine Superfund Site
TVS	Table Value Standards
µg/L	microgram per liter
$\mu g/m^3$	micrograms per cubic meter
UAO	Unilateral Administrative Order
WQCD	Water Quality Control Division of the Colorado Department of Public Health and Environment
WQCC	Colorado Water Quality Control Commission
WRP	Waste Rock Pile
WTP	Water Treatment Plant
As	Arsenic
Pb	Lead
Cd	Cadmium
Cu	Copper
Zn	Zinc

Executive Summary

The Environmental Protection Agency (EPA) has conducted the third Five-Year Review of the remedial actions implemented at the Eagle Mine Superfund Site (Site) near Minturn, Eagle County, Colorado. This review was conducted from April through June 2008, three years after the second Five-Year Review completed in September 2005. This third Five-Year Review was conducted in 2008 in order to coordinate remedy protectiveness evaluation with the Eagle River water quality standards-setting process conducted by the Colorado Water Quality Control Commission (WQCC).

The Site is located in Eagle County, Colorado, approximately 1 mile southeast of Minturn and includes the Eagle River and its tributaries between the towns of Red Cliff and Minturn. It is divided into two operable units comprising 235 acres incorporating various underground hard rock mine workings, mine waste deposits and the abandoned community of Gilman. Unconsolidated stream and glacial deposits are found throughout the Site. Ground water flows through the unconsolidated stream and glacial deposits, mine workings and fractured bedrock.

The Eagle Mine was one of the largest zinc mines in the United States and operated until 1977. The land changed hands several times with the majority currently held by Ginn Battle North and Ginn Battle South (the Ginn Entities, a resort developer). Other portions of the Eagle Mine are held by the Glenn Miller bankruptcy trustee.

The most significant environmental impact from the Site is degradation of water quality in the Eagle River due to dissolved metals, including cadmium, copper, iron, manganese and zinc, originating predominantly from roaster wastes and tailing. Ground water is also impacted by mining wastes. Ground water within underground mine workings encounters ore-bearing rock that is acid-generating. This leads to contamination of the water within the underground mine workings (referred to as the "mine pool"). Some of this ground water discharges to the Eagle River and its tributaries.

Mine wastes and soils removed through prior remedial actions and also remaining on the land surface in certain portions of the Site contain contaminants that may result in adverse human health effects (including arsenic and lead). These mine wastes include waste rock, and ore processing wastes ("roaster" wastes and mill tailing).

Response actions implemented at the Site include:

- Collection, conveyance and treatment of contaminated ground water and seeps.
- Consolidation and isolation of mine wastes.
- Diversion of clean ground and surface water around mine features.

Risks to human health from Site wastes have either been reduced through response actions or pose a human health risk below a level of concern under a trespasser exposure scenario.

This exposure scenario is appropriate for the current land use across the vast majority of the Site. One exception to this exposure scenario is the Minturn Middle School where risks associated with mine-related contamination were also determined to be below a level of concern for child students.

Portions of the Site may be developed for residential and recreational uses by the Ginn Entities. Such changes in land use (should they occur) will require modifications to Site decision documents as well as additional response actions to ensure development is consistent with final land use. Response actions may also include environmental covenants, as necessary. However, this Five-Year Review considers the Site in its current condition when evaluating remedy protectiveness.

Assessment and mitigation of risks to the environment have largely focused on the aquatic ecosystem. Many response actions were intended to reduce metal loading to Site surface water and to a lesser extent, to Site ground water. Both of these environmental media have shown improvement since the implementation of response actions. Contaminant levels in shallow ground water and surface water have decreased, and the aquatic ecosystem is recovering. However, additional response actions are necessary to achieve protection of the aquatic ecosystem. The Colorado WQCC established new water quality standards in June 2008. The Site does not comply with the standards and will not in the future without further reductions in zinc loading through additional response actions.

Assessment of Site compliance with chemical-specific ARARs is complicated by the absence of formal points of compliance (POC) for surface and ground water. In addition, compliance monitoring against the new surface water quality standards (established in June 2008) has not occurred. The location of POCs, monitoring schedules and any additional response actions necessary to meet chemical-specific ARARs will be identified and documented in an Explanation of Significant Differences (ESD) or Record of Decision (ROD) Amendment.

The results of the review indicate that the remedies implemented at the Eagle Mine Superfund Site are currently protective of human health. As discussed above, additional response actions are necessary to achieve protection of the aquatic ecosystem. Remedy elements implemented to date are largely operating and functioning as designed. In addition, all nearby residents and businesses are connected to the local water system. Access controls are in place throughout the Site including Gilman. A number of issues that do not immediately impact the protectiveness of the remedies were identified and will be addressed as summarized in the following tables.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: Eagle Mine		
EPA ID *(from WasteLAN)*: COD081961518		
Region: 8	**State:** CO	**City/County**: Minturn/Eagle County

SITE STATUS	
NPL status: X Final Deleted Other (specify)	
Remediation status (choose all that apply): Under Construction X Operating X Complete	
Multiple OUs? X YES NO	**Construction completion date**: 09/17/2001
Has site been put into reuse? YES X NO	

REVIEW STATUS	
Reviewing agency: x EPA State Tribe Other Federal Agency	
Author name: Michael Holmes	
Author title: Project Manager	**Author affiliation:** US Environmental Protection Agency
Review period: April through September 2008	
Date(s) of site inspection: 4/29/08	

Type of review:

x Post-SARA Pre-SARA NPL-Removal only

Non-NPL Remedial Action Site X NPL State/Tribe-lead

Regional Discretion

Review number: 1 (first) 2 (second) X 3 (third) Other (specify)

Triggering action:

Actual RA Onsite Construction at OU #___ Actual RA Start

Construction Completion

X Other (specify) - Need to coordinate Five-Year Review process with regular meeting of Colorado Water Quality Control Commission

Triggering action date: This review is being conducted three years after the second Five-Year Review completed in September 2005. This third Five-Year Review is being conducted in 2008 in order to coordinate remedy protectiveness evaluation with the Eagle River water quality standards-setting process conducted by the Water Quality Control Commission.

Due date: September 2008

*["OU" refers to operable unit.]

Five-Year Review Summary Form, cont'd.

Issues:

Item No.	Issues	Affects Current Protectiveness	Affects Future Protectiveness
1	The two CDs currently in place effectively addressed the completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish Points of Compliance (POCs) and time frame for compliance with ARARs.	No	Yes
2	Surface water quality in the Eagle River is not protective of brown trout.	Yes	Yes
3	Institutional controls (ICs) to regulate development under existing or revised land zoning in OU1 were not required under the ROD. Such ICs are necessary to ensure the future land use is consistent with the remedy. These ICs were required under the OU2 ROD but were not formally implemented. Development of portions of OU1 and OU2 as a ski resort with residential development is proposed for implementation within the next several years. Such development will comply with the ICs.	No	Yes
4	Institutional controls prohibiting new wells required under the OU1 ROD have not been implemented.	No	Yes
5	Physical limits of OU1 and OU2 have not been defined. Therefore, the area over which OU-specific ICs apply is unclear.	No	Yes
6	Apparent excessive settlement on Consolidated Tailing Pile (CTP) resulting in ponded water observed during the Site inspection.	No	Yes
7	Geomembrane liner in temporary cell on CTP in poor condition.	No	Yes
8	The Mine at Adit #8 has partially collapsed presenting a safety hazard for personnel entering the mine.	No	No
9	Proposed redevelopment could potentially impact human health and the environment during and after implementation.	No	Yes

Five-Year Review Summary Form, cont'd.

Recommendations and Follow-up Actions:

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
1	The two CDs currently in place effectively addressed the completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish Points of Compliance (POCs) and time frame for compliance with ARARs.	The State and EPA will develop a CD that updates terms, established performance standards, POC(s), ARAR compliance schedule, current/future activities, reporting requirements, schedules and any other items. These requirements will be incorporated into a Compliance Monitoring Plan (CMP).	EPA/CDPHE/CBS	EPA/ CDPHE	12/31/09	No	Yes
2	Surface water quality in the Eagle River is not protective of brown trout.	Revision of water quality standards through Water Quality Control Commission (WQCC) occurred in June 2008. New standards adopted by the WQCC become performance standards for the Site surface water and will be incorporated into the CD discussed in Issue No. 1. The new water quality standards will be identified as Site ARARs in an ESD or ROD Amendment. Additional response actions would be required to comply with the new performance standards and would be implemented as discussed in the Metals Loading and Water Quality Standards Attainability Analysis (CDPHE, 2008), at a minimum. Such additional response actions would be identified in an ESD or ROD Amendment and the CD discussed in Issue No. 1.	CDPHE and EPA	EPA/ CDPHE	New water quality standards - June 2008. ESD or ROD Amendment – 9/30/09 Implementation of additional response actions – To be determined and defined in the CD discussed in Issue No. 1.	Yes	Yes

Recommendations and Follow-up Actions (cont'd):

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
3	Institutional controls (ICs) to regulate development under existing or revised land zoning in OU1 were not required under the ROD. Such ICs are necessary to ensure the future land use is consistent with the remedy. These ICs were required under the OU2 ROD but were not formally implemented. Development of portions of OU1 and OU2 as a ski resort with residential development is proposed for implementation within the next several years. Such development will comply with the ICs.	Prepare an ESD or ROD Amendment identifying the need for ICs and the form the ICs will take. This may include environmental covenants (Colorado Environmental Covenant Law, C.R.S. §§ 25-15-317 to 25-15-327) for areas of the Site where the land owner is willing to enter into such agreements, County ordinances or other mechanism to maximize the likelihood that appropriate government entities control and/or oversee changes in land use.	EPA/CDPHE/ Minturn or Eagle County	EPA/ CDPHE	ESD or ROD Amendment – 9/30/09 Environmental Covenants – To be determined based on land redevelopment plans. Other ICs – 12/31/09	No	Yes
4	Institutional controls prohibiting new wells required under the OU1 ROD have not been implemented.	Formalize and enforce the ICs through an Environmental Covenant.	Minturn and Eagle County	EPA/ CDPHE	12/31/09	No	Yes
5	Physical limits of OU1 and OU2 have not been defined. Therefore, the area over which OU-specific ICs apply is unclear.	Define OU boundaries through resolution of Issue Nos. 3 and 4.	EPA/CDPHE	EPA/ CDPHE	9/30/09	No	Yes
6	Apparent excessive settlement on CTP resulting in ponded water observed during the Site inspection.	Repair cover to reestablish surface drainage.	CBS	EPA/ CDPHE	12/31/09	No	Yes
7	Geomembrane liner in temporary cell on CTP in poor condition.	Repair geomembrane.	CBS	EPA/ CDPHE	12/31/09	No	Yes

Recommendations and Follow-up Actions (cont'd.):

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
8	The Mine at Adit #8 has partially collapsed presenting a safety hazard for personnel entering the mine.	The State and EPA will work with CBS to address the rehabilitation of the mine tunnel to ensure continued access to the mine workings and to allow periodic confirmatory measurements of the mine pool elevation.	CDPHE CBS EPA	EPA/ CDPHE	12/31/09	No	No
9	Proposed redevelopment could potentially impact human health and the environment during and after implementation.	The current property owner (Ginn Entities) has requested Bona Fide Prospective Purchaser Status and therefore will be required to perform additional actions at the Site to place the Site in a condition that is consistent with the intended land use. These actions will be documented under future decision documents.	CDPHE/EPA/ Ginn Entities	EPA/ CDPHE	12/31/11	No	Yes

Protectiveness Statement(s):

The following protectiveness statements apply to OU1, OU2 and Site-wide surface water quality.

OU1

The remedy at OU1 currently protects human health and the environment through implementation of various actions to isolate contaminants from humans as well as collection and treatment of contaminated surface and ground water. However, in order for the remedy to be protective in the long-term, Institutional controls (ICs) to regulate development under existing or revised land zoning are necessary to ensure future land use is consistent with the remedy. In addition, ICs to prohibit new water wells must be formalized.

The two Consent Decrees (CDs) currently in place effectively addressed completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish Points of Compliance (POCs) and time frame for compliance with ARARs. New CDs will have to be developed in order to ensure protection of human health and the environment in the long-term.

OU2

The remedy at OU2 currently protects human health and the environment through implementation of access restrictions and an IC in the form of a commitment by the Eagle County Sheriff's department to patrol the Gilman area and arrest trespassers. However, in order for the remedy to be protective in the long-term, ICs to regulate development under existing or revised land zoning are necessary to ensure future land use is consistent with the remedy.

Site-wide

The remedy is not protective of human health and the environment because additional response actions are necessary to achieve protection of the aquatic ecosystem. New water quality standards have been adopted by the Colorado Water Quality Control Commission. The Site does not comply with the standards and will not comply in the future without further reductions in zinc loading through additional response actions.

Other Comments:

A large data base consisting of recently collected Site-wide surface soil/mine waste chemical concentrations has been developed by a private party (Ginn Entities) interested in developing a portion of the Site for recreational and residential use. These data are being used to support risk estimates as well as to develop mitigation strategies and plans to allow development consistent with the remedy.

It may be appropriate to use these data to perform an assessment of any remaining risks to human health under current land use (trespasser scenario). This exercise would help to confirm the protectiveness of prior response actions should portions of the Site remain under current land use in the near- or long-term.

I. Introduction

Purpose of the Review

The purpose of Five-Year Reviews is to determine whether response actions at a site are protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues found during the review, if any, and makes recommendations to address them.

Authority for Conducting the Five-Year Review

The U.S. Environmental Protection Agency (EPA) is preparing this third Five-Year Review pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) §121 and the National Contingency Plan (NCP). CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The EPA interpreted this requirement further in the NCP; 40 CFR §300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

The response actions conducted at the Site (See Section IV) resulted in Site conditions that do not allow for unlimited use and unrestricted exposure. Therefore a Five-Year Review is required by statute.

Who Conducted the Five-Year Review

The EPA Region 8 conducted the third Five-Year Review of response actions implemented at Eagle Mine Operable Unit (OU) 1 and 2 National Priorities List (NPL) Site (the Site) near Minturn, Colorado. This review was conducted from April through September 2008. This report documents the results of the review. HDR Engineering, Inc. (HDR) of Denver, Colorado was retained by US Army Corps of Engineers, Kansas City District to provide technical support during preparation of the Five-Year Review Report.

Other Review Characteristics

This review is being conducted three years after the second Five-Year Review completed in September 2005. This third Five-Year Review is being conducted in 2008 in order to coordinate remedy protectiveness evaluation with the Eagle River water quality standards-setting process conducted by the Colorado Water Quality Control Commission (WQCC).

Portions of the Site may be developed for residential and recreational uses. Such changes in land use (should they occur) will require modifications to Site decision documents as well as additional response actions. However, this Five-Year Review considers the Site in its current condition when evaluating remedy protectiveness. In addition, the remedy is assessed for appropriate institutional controls to maintain protectiveness under future changes in land use.

II. Site Chronology

Table 1 summarizes the important events and relevant dates in the Site's chronology.

Table 1 - Chronology of Site Events

Late 1870's	Gold & Silver deposits were discovered on Battle Mountain.
1905	Mining of lead-zinc deposits began.
1905	Roasting and magnetic separation used to process ore.
1912	Underground mill constructed that used froth-floatation to generate lead-zinc concentrate.
1942-1946	Old Tailing Pile abandoned. New Tailing Pile (now called CTP) opened.
1983	State of Colorado filed suit under CERCLA for damages to natural resources.
Summer 1984	EPA performed Emergency Removal of transformers containing PCBs from within the mine workings. Transformers were threatened by rising water levels in the mine after dewatering pumps were turned off.
1984	Mine workings flood.
October 15, 1984	Site proposed for listing on the National Priorities List (NPL).
June 10, 1986	Final listing on the NPL.
1986	State of Colorado settled with Potentially Responsible Party (PRP), Consent Decree/Remedial Action Plan finalized (CD/RAP).
June 1988	State of Colorado completed the Remedial Investigation/Feasibility Study (RI/FS).
1988	Remediation under the CD/RAP began.
1990	As water levels in the mine rose, seepage began to reach the Eagle River.
1990	PRP installed a package Water Treatment Plant to treat water from the mine pool and seepage from the mine.
1991	PRP upgraded to a customized Water Treatment Plant.
March 29, 1993	EPA issued OU1 ROD.
1994	EPA issued Unilateral Administrative Order (UAO).
1996	Three Party Consent Decree/Statement of Work (CD/SOW) signed.

Table 1-Chronology of Site Events (cont'd.)

Date	
September 3, 1998	EPA issued OU2 ROD.
1999	Explanation of Significant Differences (ESD) issued for the Liberty Well (OU1).
September 2000	First Five-Year Review conducted.
June 2001	Preliminary Site Closeout Inspection conducted.
September 17, 2001	EPA issued Preliminary Site Closeout Report/Construction Complete declared.
December 2004	Portions of the Site purchased by Ginn Entities.
March – May 2005	Community Interviews conducted for second Five-Year Review.
April 2005	Five-Year Review Site Inspection conducted.
March – August 2005	Second Five-Year Review conducted.
June 2006	Installation of three ground water extraction wells in Belden with gravity conveyance to the WTP.
August-September 2006	Removal and disposal (to the CTP temporary cell) of Belden Roaster Waste (Waste Rock Pile 14).
October 2007	Construction of ground water extraction trench in Belden with gravity conveyance to the WTP.
April-September 2008	Third Five-Year Review conducted.

III. Background

Location and Setting

The Eagle Mine NPL Site is located in Eagle County, Colorado, approximately 1 mile southeast of Minturn, eight miles southwest of Vail and 110 miles west of Denver. The Site is defined as the area impacted by past mining activity along and including the Eagle River between the towns of Red Cliff and Minturn in Eagle County, Colorado. The Site is comprised of 235 acres including the Eagle Mine workings, former Town of Gilman, former Roaster Pile areas, Waste Rock Piles, Rex Flats, Old Tailing Pile (OTP), Consolidated Tailing Pile (CTP), Maloit Park, water diversion components around the CTP, water treatment plant (WTP), a tailing slurry line and trestle, mine seepage and associated collection systems, and the Belden mill and load out area. The Site is bordered on the south and west by the White River National Forest (See Figure 1 in Attachment A for Site Features).

The Site is divided into two operable units (OU). Some inconsistencies exist in the Site files with respect to OU boundaries. The Record of Decisions (RODs) indicate that OU1 includes the entire Site except for the abandoned company town of Gilman which comprises OU2. However, the OU2 ROD identifies certain mine waste features outside of Gilman as being part of OU2 (e.g. Maloit Park; See Figure 1 in Attachment A).

Gilman is located on Battle Mountain and was once home to as many as 350 Eagle Mine employees and their families. Gilman covers approximately 50 acres and includes an estimated 90 buildings. Many of the abandoned houses in Gilman were built in the 1940s and 1950s and numerous buildings have been vandalized and are in a state of disrepair.

The Eagle River is the major surface water resource affected by the Eagle Mine. The headwaters of the Eagle River originate at elevations of 10,000 to 14,000 feet, miles from the Site. Water from the Eagle River is used for domestic, irrigation and recreational purposes. Rock Creek is a small tributary to the Eagle River in the vicinity of Gilman. Cross Creek is another tributary to the Eagle River and originates in the Holy Cross Wilderness Area. The Eagle River and its tributaries are identified on Figure 2 (Attachment A).

Unconsolidated stream and glacial deposits are found throughout the Site. Ground water flows through the unconsolidated stream and glacial deposits, mine workings and fractured bedrock.

Site History and Extent of Contamination

Eagle Mine was one of the largest zinc mines in the United States, and a major domestic source of zinc. According to statistics from the Colorado Geological Survey, Eagle Mine produced 12,837,000 tons of ore. The average ore grade was 8.5% zinc, 1.5% lead, 0.9% copper, 228 parts per million (ppm) silver and 1.7 ppm gold. Eagle Mine was also famous for its precious mineral specimens, especially pyrite, barite, rhodochrosite, galena and sphalerite.

Mining began in the area in the late 1870's as miners discovered oxidized silver-lead and gold-silver ores in the Leadville Dolomite and Sawatch Quartzite. As mine workings passed downward from lead-silver ores of the oxidized zone, sulfide ores, containing lead and zinc, were encountered. The zinc ore was originally processed using a roaster and magnetic separation process.

Roaster wastes were deposited in multiple locations using a tramway system, along the banks of the Eagle River and on steep canyon sideslopes at higher elevations. The roasting process was inefficient, therefore, roaster wastes had very high leachable metals content. In 1912, the Empire Zinc Company, later a subsidiary of New Jersey Zinc Company, began consolidating individual mining claims (including the Little Chief, Iron Mask, Belden and Black Iron mines) into what is now known as Eagle Mine.

In 1929, a conventional froth-flotation mill was constructed within the mine workings due to space constraints. Mill tailing were slurried through a wood-stave pipeline/trestle system to a location down stream, known as the Old Tailing Pile (OTP). In the mid-1940s, the OTP reached capacity. At that time, tailing were deposited across the Eagle River from the OTP in an area known as Rex Flats.

In 1942, the pipeline was extended to a location near Cross Creek using an elevated wooden trestle to cross Rex Flats and the New Tailing Pile (now known as the CTP). The New Tailing Pile also included a 15-acre water retention pond known as the Historic Pond. Rex Flats again received tailing in the 1950s apparently to kill the vegetation and reduce fire hazard to the trestle. In December 1977, Gulf & Western closed down the mill and most mining activities ceased. In September 1983, Colorado businessman Glenn T. Miller purchased the Eagle Mine, Town of Gilman and certain surrounding property. Miller then sold approximately 1,400 acres to Battle Mountain Corporation (BMC), including the Town of Gilman, OTP and the CTP. In 1984, the property was abandoned, the pumps that were keeping the mine dry were shut off and the mine began to fill with water. Due to non-payment of property taxes, most Eagle Mine properties were sold at tax sales. Some properties were reconsolidated by Turkey Creek Limited and then sold to Ginn Battle North and Ginn Battle South (hereinafter referred to as Ginn Entities) in December 2004. Other portions of Eagle Mine remain with the Glenn Miller bankruptcy trustee.

Several different types of wastes were present at the former mine and causing environmental impacts. Sources of contaminated water included:

- Mine Pool - Water within the mine workings.
- Historic Pond – Water stored at the CTP from various sources.
- Runoff - Water from areas containing mine wastes.
- Ground water at the OTP, CTP, Rex Flats, Rock Creek and Belden areas.

Solid mining wastes include the following:

- Waste Rock - Rock that was removed when mine tunnels and adits were constructed. Waste Rock has not been processed to remove metals and therefore, usually does not present as great a leaching hazard as other waste sources (e.g. roaster wastes and tailing). Waste Rock was discarded on the hillside overlooking the Eagle River and Rock Creek, and is held in place by wooden cribbing in some areas.

- Roaster Wastes - Waste that was produced from the inefficient process of roasting and magnetic separation. Roaster waste contains a large amount of highly leachable metals and was discarded near the river and on steep side slopes. Five distinct Roaster Piles were present at the Site.
- Mill Tailing - Fine-grained waste material from the milling process. Although most heavy metals were removed during milling, tailing still contained leachable metals and usually have a low pH, thus, generating additional acidity and further leaching.

The most significant environmental impact from the Site was degradation of Eagle River water quality from dissolved metals, including cadmium, copper, iron, manganese and zinc, originating predominantly from roaster wastes and tailing. Eagle River water quality exhibits significant seasonal variation. An early spring "high metals" season and a longer "low metals" season are evident. Onset of "high metals season" occurs as snow begins to melt in early spring (typically early March) mobilizing metals present in mine wastes. This snowmelt reaches the Eagle River during typically low flow conditions in March and April. As snow melts at higher elevations later in spring, upstream and tributary flows of clean water increase and dilute metal concentrations in the river.

Extensive studies at the Site show that zinc occurs in the highest concentrations and other metals associated with mine wastes (with the possible exception of copper) show a high degree of correlation with dissolved zinc concentrations in surface water.

Tributaries to Eagle River including Rock and Cross Creeks have also been impacted by metals originating from mine wastes within their watersheds. Rock Creek has been impacted from these contaminant sources as well as seepage from underground mine workings. Historical contamination from the CTP and ground water seepage has resulted in degradation of water quality in Cross Creek.

Ground water resources at the OTP, Rex Flats, Rock Creek and CTP were also impacted by mining wastes. Ground water within underground mine workings encounters ore-bearing rock that is acid-generating. This leads to contamination of water within underground mine workings (referred to as the "mine pool"). Ground water in the Belden area is also contaminated, most likely from a multitude of waste sources including ballast material beneath the rail lines that may contain roaster wastes, mill tailing or waste rock.

Baseline Risk Assessment

Potential contaminant-related risks to human health for the Eagle Mine Site have been assessed in 14 separate reports. The 1997 Risk Assessment for Gilman Townsite (MK, 1997) summarized the findings of those reports that addressed Site soils. That summary is reproduced below. An additional risk assessment addressing site soils was recently (2007) prepared by the Ginn Entities to support Site development.

1. ESI 1985. *Eagle Mine Remedial Investigation*, Engineering Science, Inc. December 2, 1985.

The Remedial Investigation (RI), conducted by ESI, was not intended to be a risk assessment, although a discussion of "Environmental and Public Health Effects" is presented at the conclusion of several sections (Reif 1993) footnote.

These sections include only a qualitative discussion of risk and do not use toxicological or epidemiological analyses to draw conclusions (Reif 1993). The RI provided limited soil and waste-rock analytical data which included analytical chemistry for waste rock in the Gilman Area.

2. Colorado 1998. State of Colorado's Endangerment Assessment, Eagle Mine Superfund Site, Gilman, Eagle County Colorado, May 1998.

This report was prepared by the State of Colorado to assess the effects that the proposed Site remediation would have in reducing or eliminating potential health or environments risks. The report focused on potential effects from lead and cadmium and reviewed the following exposure pathways: 1) inhalation, ingestion or direct contact with soils and fugitive dust; 2) ingestion of ground water and surface water; 3) direct contact with water and sediment, and, 4) ingestion of fish, wildlife or vegetation from the site. This EA is not a rigorous risk assessment and is only semi-quantitative. The inclusion of arsenic would have provided a more complete assessment. The EA was useful in its description of potential pathways of exposure and in its identification of Minturn Middle School students as potentially the most significant receptors.

3. CDH 1989. *Health Assessment of Eagle Mine NPL Site*, Colorado Department of Health, in conjunction with the Agency for Toxic Substances and Disease Registry, March 1989.

In 1989 the Colorado Department of Health (CDH) in conjunction with the Agency for Toxic Substance and Disease Registry (ATSDR), conducted a Health Assessment for the Eagle Mine Site to evaluate possible adverse effects. This Health Assessment provided a semi-quantitative analysis of risk; however, it relied upon an incomplete database to estimate potential exposures and health effects. This assessment is a screening-level evaluation based on highly conservative estimations of risk. The evaluation recommended, arsenic, cadmium, chromium, and lead for further monitoring.

4. Slosky 1989. Risk Assessment for Metals Exposure at the Minturn Middle School, Slosky & Company, Inc. August 7, 1989.

The Eagle County School district commissioned Slosky & Co. to conduct this risk assessment for Minturn Middle School. This was the first quantitative risk assessment for the Eagle Mine Site. It evaluated the following pathways: 1) inhalation of tailing; 2) inhalation of soil or dust; 3) ingestion of inhaled particulates; and 4) ingestion of soil and dust. The metals considered were: arsenic, cadmium, chromium, lead, manganese and nickel. The major finding of the risk assessment was that exposures to metals in air and soil/dust were not likely to be associated with unacceptable health risk for students attending the Minturn Middle School.

The assessment had scientific shortcomings in that it did not provide raw data, QA/QC information, nor information on sampling protocols. Additionally, the exposure assumption used for soil/dust ingestion was an order of magnitude below the recommended 100 mg/day (EPA 1989).

5. CDH 1990. Assessment of Risk Associated with the Potential Exposure of Children to Metals in Airborne Mine Wastes at the Minturn Middle School and Maloit Park Area, Minturn, Colorado. Health Consultation Colorado Department of Health, March 1990.

This report expanded the results of the 1989 CDH draft risk assessment (3) by using more recent air monitoring data. These data were use to quantitatively assess the inhalation risk for children attending the Minturn Middle School or living in the vicinity of Maloit Park. The cancer risks for inhalation exposure to arsenic, cadmium, and chromium within the study areas were within the acceptable ranges for Superfund Sites (<1E-4). The estimated blood lead levels were also acceptable.

6. Slosky 1992a & 1992b. *Risk Assessment for Metals Exposure to Residents of Maloit Park and Employees of the Minturn Middle School* January 31, 1992, and the Technical Appendix March 1992. Slosky & Company, Inc.

This study is the companion document to the 1989 study by the same author (4). It estimates inhalation and ingestion risks for arsenic, cadmium and lead to residents of Maloit Park and employees of the Minturn Middle School. It also attempted to recreate historical exposures prior to the availability of monitoring data (1981 to 1988). Risk estimates for historical exposures were based on modeling and assumptions about historical metal concentrations and dust levels in air. As a result, these models and assumptions (in contrast to direct measures) contribute to the uncertainty surrounding the historical risk estimates; however, the overall results of this risk assessment indicate that current levels of metals do not pose a risk to human health.

7. CDH 1992. Assessment of Risk Associated with Potential Exposure of Children to Metals in Airborne Mine Wastes at the Minturn Middle School and Maloit Park Area, Minturn, Colorado. Health Consultation, Colorado Department of Health, February 1992.

This report provides a follow-up to earlier assessments by the Colorado Department of Health (3, 5) to evaluate risks of exposure to airborne mine wastes and contaminated soils that could result from a longer remediation schedule. These changes extended the potential exposure period, which slightly increased risk estimates. While this quantitative evaluation of inhalation risks from arsenic, cadmium and lead yielded slightly higher risk estimates than previously identified (3,5), they were within the acceptable range for Superfund Sites. The report concluded that risk estimates are influenced by the duration of remedial activities and recommended that the surfaces of tailing piles susceptible to wind erosion continue to be reduced.

8. Reif 1993. Final Report on the Health Risk Assessments for the Eagle Mine Superfund Site for the Eagle Mine Superfund Site, Minturn Colorado, John S. Reif, April 1993.

The purpose of the Reif Report was to review the risk assessments of the Eagle Mine Site (1-7). The Reif report concluded (based on these prior investigations), that there were no unacceptable health risks associated with metal exposures from the site.

Further, Reif concluded that future risk assessments using the principle metals found at the site (arsenic, cadmium, chromium and lead) should be predictive of actual risks at the site. As a final recommendation, it is suggested that a comprehensive risk assessment be conducted at the site to include all potential exposure pathways (ingestion of soil and water, inhalation of dusts, dermal exposure to soil and water, and consumption of fish and vegetables). This comprehensive baseline risk assessment would add confidence to the conclusions drawn from the individual assessment of isolated exposure routes.

9. MK/ICF 1993. Health Risk assessment for Maloit Park Wetlands and Screening-Level Assessment for Selected Study Areas. Eagle Mine Site, Minturn Colorado. Morrison Kundsen Corporation (MK) and ICF Kaiser Engineers, Inc. (ICF), July 30, 1993.

This assessment, conducted subsequent to the Reif Review (8), quantitatively evaluates the potential health risk to children from the Maloit Park wetlands through incidental ingestion. Only incidental ingestion was evaluated because it was considered to be the greatest contributor to overall health risks. Children were the only receptor evaluated because they were considered to be potentially exposed to the greatest metal concentrations. The chemicals that were evaluated were: arsenic, cadmium, chromium, iron, lead, manganese and zinc. Potential carcinogenic risks range form 3×10^{-5} to 3×10^{-4} for the average and reasonable maximum exposure (RME) scenarios, respectively. Non-cancer hazard indices range from 0.5 to 5.0 for the average and RME scenarios. For both cancer risk and non-cancer hazard, arsenic was the principal contributor.

Tables 2 and 3 summarize the exposure pathways and risk estimates, respectively, for the nine reports summarized above. These tables are also reproduced from 1997 Gilman risk assessment (MK, 1997).

Further evaluation of the 1989 risk assessment for the Minturn Middle School and the 1997 risk assessment for trespassers at Gilman is provided in Section VII.

Table 2 - Summary of Risk Assessments and Exposure Pathways for Eagle Mine Soils

Risk Assessment	Chemicals of Concern	Exposure Pathways	Comments	Reference
Eagle Mine Remedial Investigation (ESI, 1985)	Arsenic Cadmium Lead	Inhalation – soil and dust, Ingestion – surface water and ground water, food web exposures	Not intended to be a risk assessment, qualitative discussion of risk	1
State of Colorado's Endangerment Assessment (CDH, 1988)`	Cadmium Lead Zinc	Inhalation – soil and dust Ingestion – soil, dust, surface and ground water, food web exposures Direct Contact – soil, dust, water & sediment	Semi-quantitative risk assessment; identified students at Minturn Middle School as potential receptors	2
Health Assessment of Eagle Mine NPL Site (CDH, 1989)	Arsenic Cadmium Chromium Lead	Inhalation – mine wastes and soil Ingestion – mine wastes, soil surface & ground water, fish & wildlife	Semi-quantitative screening-level evaluation based on highly conservative assumptions	3
Risk Assessment for Metals Exposure at the Minturn Middle School (Slosky & Co, 1989)	Arsenic Cadmium Chromium Lead Manganese Nickel	Inhalation – soil, dust & tailing Ingestion – soil, dust & particulates	First quantitative risk assessment; concludes that site dusts were not likely posing a health risk to Minturn Middle School students	4
Assessment of Risk Assoc. w/Potential Exposure of Children to Metals in Airborne Mine Waste (CDH, 1990)	Arsenic Cadmium Chromium	Inhalation – mine wastes and soil	Quantitative risk estimates were in the acceptable ranges	5
Risk Assessment for Metals Exposure to Residents of Maloit Park & Employees of the Minturn Middle School (Slosky, 1992a,b)	Arsenic Cadmium Lead	Inhalation – soil and dust Ingestion – soil and dust	Quantitative risk estimates; historical estimates based on models and assumptions yielded questionable results; current levels of metals do not present a risk to human health	6

Table 2 (cont). - Summary of Risk Assessments and Exposure Pathways for Eagle Mine Soils

Risk Assessment	Chemicals of Concern	Exposure Pathways	Comments	References
Assessment of Risk Assoc. w/Potential Exposure of Children to Metals in Airborne Mine Wastes (CDH, 1992)	Arsenic Cadmium Lead	Inhalation – airborne mine wastes Ingestion – airborne mine wastes	Quantitative risk Estimates were within the acceptable ranges	7
Final Report on the Health Risk Assessments for the Eagle Mine Superfund Site (Reif, 1993)	None	None	Review of prior studies (1-7) concluded that there were no excess health risks associated with the pathways evaluated at the site	8
Health Risk Assessment for Maloit Park Wetlands and Screening-Level Assessment For Selected Study Areas (MK/ICF 1993)	Arsenic Cadmium Chromium Iron Lead Manganese Zinc	Ingestion – soil	Quantitative risk evaluation for children; risk estimates approximated the acceptable ranges	9
Human Health Risk Assessment Bolts Lake Area and Areas within OU-1 of the Eagle Mine Site (Environmental Resources Management & Terra Technologies, February 2, 2007)	Organic Chemicals, Arsenic, Cadmium, Chromium, Copper, Lead, Manganese, Zinc (plus other inorganic chemicals depending upon the media	Ingestion, inhalation, dermal, for future residents, hikers, rafters, anglers, golfers and workers For surface soils, subsurface soils, groundwater, surface water, seeps and boulders.	Comprehensive Quantitative Risk Assessment for redevelopment at the site. Includes large database of exposure point concentrations that can be used to evaluate current risks	NA

Based, in part, on discussion presented in Reif 1993

Table 3 - Summary of Risk Assessments and Risk Estimates For Eagle Mine Soils

Risk Assessment	Highest Excess Cancer Risk([1])	Hazard Index([2])	Blood Lead Levels([3])	Reference
Eagle Mine Remedial Investigation (ESI, 1985)	NC	NC	NC	1
State of Colorado's Endangerment Assessment (CDH, 1988)	NC	NC	NC	2
Health Assessment of Eagle Mine NPL Site (CDH, 1989)	NC	NC	NC	3
Risk Assessment for Metals Exposure at the Minturn Middle School (Slosky & Co. 1989)	4.74×10^{-5}	Arsenic = 0.08 Cadmium = 0.003 Lead = 0.18 Manganese = 1.4	1.7 ug/dl maximum 0.32 ug/dl expected	4
Assessment of Risk Assoc. w/Potential Exposure of Children to Metals in Airborne Mine Wastes (CDH, 1990)	4.4×10^{-4}	Lead = 0.7	8.1 ug/dl	5
Risk Assessment for Metals Exposure to Residents of Maloit Park & Employees of the Minturn Middle School (Slosky, 1992a,b)	7.32×10^{-4}	Arsenic = 4.5 Cadmium = 1.8	1981-88: 7.3 ug/dl; 1989-93: 2.9 ug/dl	6
Assessment of Risk Assoc. w/Potential Exposure of Children to Metals in Airborne Mine Wastes (CDH, 1992)	1.03×10^{-5}	NC	3.23 ug/dl	7
Final Report on the Health Risk Assessment for the Eagle Mine Superfund Site (Reif, 1993)	NC	NC	NC	8
Health Risk Assessment for Maloit Park Wetlands and Screening-Level Assessment for Selected Study Areas (MK/ICF 1993)	3×10^{-4}	Arsenic = 4.5 Cadmium = 0.002 Chromium = 0.026 Manganese = 0.9 Zinc = 0.006	3.06 ug/dl	9

[1] Acceptable carcinogenic risk range of 1×10^{-6} to 1×10^{-4}

[2] Acceptable non-carcinogenic risk level of < 1.0

[3] Acceptable blood lead level of 10 ug/dl

NC: Not Calculated

IV. Response Actions

Decision Documents and Responsible Party

The State of Colorado filed a Natural Resource Damages (NRD) lawsuit under CERCLA in 1983. The Site was listed on the National Priorities List (NPL) on June 10, 1986, because of mine discharge (metals), uncontrolled mine waste piles and close proximity of the population to the mine and associated features. In the same year, the EPA and the State of Colorado entered into an agreement designating the State as lead agency for Site remediation. The State remedy was detailed in a 1988 Consent Decree (CD) with Gulf+Western and a Remedial Action Plan (RAP), known as the CD/RAP.

The Responsible Party currently implementing the clean-up project under CERCLA at the Eagle Mine Site is CBS Operations, Inc. (CBS). CBS acquired Viacom International, Inc. (Viacom), the successor in interest to New Jersey Zinc Company, a former operator of the Eagle Mine. New Jersey Zinc Company was acquired in 1966 by Gulf & Western Industries, Inc., which later changed its name to Gulf +Western, Inc., and then to Paramount Communications Inc. (Paramount). In 1994, Viacom acquired Paramount.

In 1990, EPA became aware that there was a need to address certain issues that had arisen since the 1988 CD/RAP. EPA prepared a Feasibility Study Addendum to analyze the need for additional cleanup measures. The study was completed in 1992. As a result of the study, EPA issued the Record of Decision (ROD) for OU1 in March of 1993. A Unilateral Administrative Order (UAO) was issued in 1994 by EPA as an interim measure to allow implementation of certain actions included in the ROD. A Three-Party CD and Statement of Work, known as the CD/SOW, followed the OU1 ROD and UAO.

The purpose of the OU1 remedy was to control transport of metals from various sources to the Eagle River and to ground water. Identified sources include Eagle Mine, Roaster Piles, Waste Rock Piles, Rex Flats, OTP, CTP and Maloit Park. EPA issued an Explanation of Significant Differences (ESD) for OU1 on September 1, 1999. The purpose of the ESD was to modify the agreed-upon remedy to include a new feature implemented voluntarily by the Responsible Party – a pumping well, known as “Liberty No. 4 Well” that extracts clean ground water from mine workings prior to it contacting the ore body and becoming contaminated.

Operable Unit 2 was established to evaluate potential human health risks from soils in three areas: south of Minturn, Maloit Park, and Gilman. Potential adverse health effects associated with arsenic, cadmium and lead levels at Minturn Middle School and the south end of Minturn were determined to be below a level of concern and required no action. Concentrations of metals in soil in parts of Maloit Park were above human health standards. These soils were removed and replaced with clean fill under the OU1 remedy. Soils around the abandoned Town of Gilman contain elevated concentrations of metals, and for that reason, Gilman was the remaining area addressed under the OU2 ROD. The OU2 ROD, issued by EPA in 1998, identified Institutional Controls (ICs) as the remedy for the former Town of Gilman.

Waste removal and disposal as well as ground and surface water collection, conveyance and treatment activities were conducted beyond those required under existing decision documents. Ground/surface water collection/treatment activities consisted of pilot tests. However, waste removal and disposal activities are considered to be part of remedy operation and maintenance (O&M). The work was conducted voluntarily by Viacom and later by the current Responsible Party, CBS, pending development of another CD defining long-term responsibilities in OU1. These activities and the response actions are summarized in the next section of this report (Summary of Response Actions).

Glenn Miller and BMC were defendants in the State's lawsuit of 1983. As a result, two minor CDs exist with these two defendants. The Miller and BMC CDs provided property access for cleanup work. The CDs were filed in the Eagle County Office of the Clerk and Recorder and all conveyances of title must contain a covenant providing the use and access described in the CDs. The Miller and BMC CDs have no remedial components and are not discussed further in this review.

Summary of Response Actions

The following is a summary of response actions (by OU) implemented under the decision documents.

OU1

- Treating contaminated surface and ground water collected from multiple locations (including from flooded mine workings) throughout OU1 with alkaline treatment at a water treatment plant (WTP). A temporary WTP was replaced by a permanent facility. Sludge is disposed in a lined cell on the CTP.
- Installing a well (Liberty Well) in an existing drift that connects the Eagle Mine workings to the Turkey Creek and Willow Creek watershed near Red Cliff. This response action was implemented to intercept clean water entering mine workings flooded with contaminated water. Intercepted water is discharged to Willow Creek.
- Constructing a temporary runoff control system at the OTP, Rex Flats and CTP (see Figure 1 in Attachment A for locations of site features) to pump collected water into the Eagle Mine Workings. This response action was discontinued when the WTP was constructed.
- Excavating most soils with lead concentrations greater than 500 mg/Kg from the Roaster Piles, Maloit Park, the OTP, Rex Flats and Pipeline/Trestle and consolidate in the CTP. Quantities of material excavated from each area are summarized on Table 4. Most excavated areas were vegetated and in some cases, treated with hydrated lime. CTP construction included cover with a multi-layer engineered cap, ground water extraction near the northern and eastern toes of the CTP with conveyance to the WTP, a clean ground water diversion on the western perimeter and runon and runoff control systems.
- Sealing known channels and pathways of flow from the mine workings and grout fracture zones having identifiable discharge or seepage.
- Routing storm water and other surface water flow (including lower Rock Creek) around selected waste rock piles.

- Installing, operating and maintaining various stream gauges.
- Providing municipal water service to a single residence.
- Removing transformers, oil, grease, compressed gas and other hazardous substances from the Gilman and Belden areas.
- Installing two drinking water wells for use by the Town Of Minturn.

Table 4 - Waste Material Quantities

Roaster Material	66,300
Tailing from Rex Flats	69,530
Tailing from OTP	860,000
Tailing from Pipeline/Trestle	4,000
Soil/Tailing from Maloit Park	18,000
Total	1,017,830

Source: CTP Final Construction Report

OU2

- Establishing limited Site security by maintenance of a locked gate at the roadway access to Gilman.
- Commitment by the Eagle County Sheriff's department to patrol the Gilman area and arrest trespassers. This action represents IC under OU2.

All activities required by the CD/SOW have been implemented. On June 28, 2001, EPA and the State conducted a final inspection and determined that the remedy had been constructed in accordance with all pertinent decision documents and CDs. Inspection results are documented in a September 17, 2001, Preliminary Site Close Out Report (PSCOR). A summary of major construction milestones is presented in Table 5.

Table 5 - Major Construction Milestones

Activity	Date Completed
Roaster Pile #4 removal	1989
Roaster Pile #5 removal	1988
Roaster Piles #1,2,3 removal	1989
Roaster Gulch sediment & sediment basin removal	1990,1992,1994
Rex Flats tailing removal	1988, 1996
OTP tailing removal	1991
Pipeline Trestle tailing removal	1991
CTP ground water extraction system completed	1989
CTP cap completed	1996
Maloit Park soil removal	1995, 1996
Belden "concentrate" removal	1997
Package WTP installed	1990
Customized WTP constructed	1991
Sludge Press added to WTP operation	1994

Additional waste removal and disposal as well as new ground and surface water collection, conveyance and treatment activities were conducted after final inspection. Ground/surface water collection/treatment activities consisted of pilot tests. However, waste removal and disposal activities are considered to be part of remedy operation and maintenance (O&M). The work was conducted voluntarily by Viacom and later by the current Responsible Party, CBS. These pilot tests and O&M activities included:

- Install three ground water extraction wells in Belden with gravity conveyance to the WTP.
- Construct ground water extraction trench in Belden with gravity conveyance to the WTP.
- Construct storm/seep water collection at the base of Waste Rock Pile #8 with conveyance to the WTP.
- Remove and disposal (to the CTP temporary cell) of Belden Roaster Waste (Waste Rock Pile 14).
- Remove mine waste pile cribbing in Belden.

Operation, Maintenance, Monitoring and Reporting

All activities required by the CD/RAP have been implemented with the exception of the Compliance Monitoring Plan (CMP). The CD/RAP requires that the Responsible Party submit the CMP to the State at the end of construction activities. However, because new water quality standards have been established and because many original RAP requirements were subsequently modified by the CD/SOW, the CMP must address compliance with new water quality standards and include monitoring for CD/SOW remedy components. Therefore, the State and EPA have not yet approved the CMP. However, O&M activities are being conducted by CBS and include a daily presence at the Site related to water collection and water treatment facilities. WTP operators are on-Site a minimum of 5 days per week (the WTP operates 7 day/week during the spring). CBS also periodically inspects mine bulkheads, Rock Creek Ground Water Extraction System, Rock Creek Culvert, CTP ground water extraction systems, UGDT, Liberty Well, Seep Collection System, pipelines, water collection and conveyance structures, CTP cap and ditches, and vegetation. Operation and maintenance for OU2 consists primarily of periodic inspections of Gilman for signs of trespass or vandalism of the gate. If trespassers are found on-Site, the Eagle County Sheriff's Office is contacted.

As required by the CD/SOW, Quarterly Data Reports, Annual Site Monitoring and Activity Reports, Annual Surface Water Loading Reports, Data Evaluation Reports and Aquatic Biological Monitoring Reports have been produced and submitted to EPA and CDPHE. In recent years, these reporting requirements have been modified by the agencies because of declining Site activities. The State currently requires CBS to submit an Annual Report due at the end of February and a mid-year O&M Progress Report due by the end of May. These requirements are documented in a May 11, 2007 email from Wendy Naugle of CDPHE to Dave Hinrichs of CBS.

V. Progress Since Last Five-Year Review

The non-routine activities that have taken place at the Site during the last two years (since the last Five-Year Review in 2005) are summarized below.

Ground water collection:

- Installing three ground water extraction wells in the Belden area and one well at the base of Rock Creek.
- Operating Belden ground water extraction wells in 2006 and 2007 (when solar panel power supply received direct sunlight) delivering water to the WTP via a gravity pipeline.
- Designing a ground water extraction trench in Belden and submitting plans to EPA and CDPHE. Agency approval of the design occurred in September 2007. The trench was constructed in October 2007 but did not operate until the time of this Five-Year Review.

Belden Earthwork:

- Removing mine waste pile cribbing in Belden.
- Constructing new Belden access road and gate.
- Excavating 3,036 cubic yards of talus and mill concentrates from Waste Rock Pile - 14 and place in the temporary cell at the CTP.

Rock Creek:

- Lengthening a concrete diversion dam in Upper Rock Creek.

Water Quality Standards Setting:

- Establishing temporary water quality standards for zinc through the Colorado Water Quality Control Commission (WQCC) in December 2005 for various segments of the Eagle River within the Site. The standards were based on the stream's degraded condition. This is discussed further in Section VII.
- Proposing new Water Quality Standards for the Eagle River in Proponents Prehearing Statement. A hearing before the WQCC took place in June 2008. This is discussed further in Section VII.

Of the issues identified during the last Five-Year Review (2005), the following remain unresolved. An explanation is provided as to the reason for the delay and how the issue will be addressed in the future.

1. Issues associated with Site Redevelopment

   The potential for Site redevelopment and accompanying impacts to human health through a change in land use was identified as Issue No. 1.
   The need for modification of Site decision documents to accommodate redevelopment and associated requirement for environmental covenants was identified as Issue No. 2.

   > *Plans for redevelopment have not progressed significantly since the last Five-Year Review. Therefore, these two issues remain unresolved and have been combined as Issue No. 9 in this Five-Year review. The actual time frame for redevelopment is unknown. Therefore, and estimated Milestone of December 31, 2011 was set for this issue.*

2. Issues associated with ICs

   Institutional controls through Eagle County as specified in the OU2 ROD were never implemented. This was identified as Issue No. 3 in the last Five-Year Review.

   > *There was an expectation in the last Five-Year Review that imminent redevelopment would trigger the establishment of environmental covenants. Delay in redevelopment has delayed the development of environmental covenants as the final ICs for OU2. This issue is retained in this Five-Year Review (Issue No. 2) with a Milestone Date of 12/31/09. Resolution of this issue is independent of the schedule for Site redevelopment.*

3. Issues associated with CDs

   Two CDs in place at the time of the last Five-Year Review did not adequately address current/future Operation, Maintenance and Monitoring Activities. This was identified as Issue No. 8 in the last Five-Year Review.

   > *The establishment of a new CD(s) was tied to the setting of new water quality standards. This process was completed in June 2008. Therefore, this is retained as Issue No. 1 in this Five-Year Review with a Milestone date of 12/31/09.*

VI. Five-Year Review Process

Administrative Components

This is the third Five-Year Review for the Site. The Five-Year Review was led by Michael Holmes, EPA Project Manager. The following Team Members participated in the review:

- Wendy Naugle, CDPHE Remedial Project Manager
- Rebecca Anthony, CDPHE Water Quality Division
- Jason King, Colorado Assistant Attorney General
- Warren Smith, CDPHE Community Involvement Coordinator
- James Stearns, EPA Attorney
- Jennifer Chergo, EPA Community Involvement Coordinator

EPA Contractors:

- Kenneth Napp, HDR Engineering, Inc.

This Five-Year Review consisted of the following activities: a review of relevant documents, a meeting with representatives of EPA and CDPHE during a Site visit, and data review. The schedule for the review extended through September 2008.

Community Notification and Involvement

A display ad was published in the Vail Daily on April 21, 2008, to announce the Five-Year Review and to invite public input.

Superfund community involvement staff from the EPA and CDPHE conducted interviews with various Eagle Mine Superfund Site stakeholders in May and June 2008. These interviews are valuable to the five year review process. Respondents provide their views regarding the Eagle Mine cleanup and its continued protectiveness. Often, EPA and CDPHE discover new information from these interviews to be considered in the five year review.

EPA and CDPHE conducted interviews with 19 individuals, who together represent a broad spectrum of interests. Elected officials, community representatives and federal, state, and local agency officials all participated in the interview process.

Overall, the community is pleased with the Eagle Mine Superfund Site cleanup. They generally feel that EPA and CDPHE have done a good job, and that the Eagle River is much improved. Many reference the difference between the degraded state of the river in the 1980s to the “crystal clear river that runs through Minturn today.” It was noted that the grass is growing on the caps on-Site and that there is more wildlife there today, particularly deer and elk. Further, it was mentioned that locals are more apt to eat the fish they catch than they once were, and the cleanup has brought the rainbow trout back to certain sections of the Eagle River.

However, almost all respondents felt that while the cleanup remains protective of human health, it is still not entirely protective of the environment. The following issues or concerns were brought to EPA and CDPHE's attention by more than a few of the respondents.

While it was pointed out that the fish are doing better in the river below Gore Creek, this recovery is not as evident upstream. Most people interviewed feel there is still potential to remove more zinc from the Eagle River. One interviewee summed up the feeling of many by saying that "to do this right, let's look at all potential source areas." Some of the most-often mentioned source areas included the Dog Hole, Gilman, Belden Cribbings, and the fill under the railroad track. With regard to these concerns, one respondent noted that EPA and CDPHE could do a better job communicating how the cleanup is constricted by the requirements set forth in the Record of Decision (ROD).

There is much concern and seeming lack of information regarding what will be required of the Eagle Mine Superfund Site should it be developed. The idea of placing — and watering — a golf course on top of the Consolidated Tailings Pile is cause for concern to many respondents. There are many questions about the composition of the liner and many believe that, as "all liners can be torn," this is not a sound idea, particularly in the long term.

A few respondents mentioned they were concerned about a general lack of maintenance at the Eagle Mine Superfund Site from the previous five year review in 2005. One respondent illustrated this point at the Old Tailings Pile, which shows some possible seepages coming through the cap and leaking from the adjacent ditch.

None of the interviewees are aware of specific trespassing or vandalism problems at the Site, but acknowledge the likelihood of trespassing.

The community at large is not concerned about the Eagle Mine Superfund Site, and most are not even aware that it is a Superfund site, according to all interviewees. This lack of awareness worries some of the respondents. One interviewee said that it's a concern that "most people don't know it's a Superfund Site, but the mine's still there, water is backed up in it and rising, waste rock is still there, and the railroad is built on tailings."

One respondent noted that newcomers to the area think of the Site as a potential Ginn development site, but have no idea that it's a Superfund site. This person suggested occasionally reminding the community about the Superfund site via some kind of update.

Respondents suggested distributing information to the public about how the remedy has positively affected the river over time. Other ideas included distributing before and after pictures or even developing an Eagle Mine Superfund Site cleanup display at the local library.

According to the respondents, most people in the community prefer to get their information from the Vail Daily. The Vail Trail is not widely read and the Eagle Valley Enterprise usually runs many of the Vail Daily stories anyway. Some indicated that a periodic community newsletter about Site progress would be well received. One respondent suggested putting Site information on the Minturn town Website.

The interviewees themselves feel fairly well informed about the Site and get the bulk of their information about it from the Eagle River Watershed Council or by calling the CDPHE project manager directly. All indicated that they would be interested in receiving update emails.

As previously stated, most respondents appear to be satisfied with the Eagle Mine Superfund Site cleanup. Almost all of the respondents feel that the remedy remains protective of human health. However, almost all of the respondents also feel that more could be done to improve the Eagle River water quality even further, and that the remedy is not protective enough of the environment.

There is a great deal of interest in addressing non-Superfund sources of metals to the Eagle River. One respondent noted that there is community interest in getting "as permanent a fix as possible." Along those lines, there is a feeling among many that biological and water quality monitoring should always continue. There is also a concern that money for that monitoring might not be available in the future.

Document Review

In performing this Five-Year Review, the following documents were reviewed:

- Metals Loading and Water Quality Standards Attainability Analysis for the Eagle Mine Superfund Site, prepared by CDPHE, April 2008.
- Memorandum from Dale Hoff, Ph.D. of USEPA to Wendy Naugle of CDPHE in connection with development of site-specific standards for copper and zinc in the Eagle River, March 25, 2008.
- Proponent's Prehearing Statement to the Colorado Water Quality Control Commission, prepared by CDPHE, 2008.
- Eagle Mine Annual Report, prepared by Newfields, February 29, 2007.
- Eagle Mine Annual Report, prepared by Newfields, March 9, 2006.
- Factors Influencing Brown Trout Populations in Mine-impacted Reaches of the Eagle River following Remediation Efforts, prepared by Colorado Division of Wildlife, October 3, 2005.
- Biological Monitoring Report for the Eagle Mine Superfund Site 1990-2005, prepared by Woodling, J., Rollings, A., and Wilson, J., July 2005.
- Five Year Review Report for Eagle Mine Superfund Site, prepared by CDPHE, September 2005.
- Explanation of Significant Differences, Eagle Mine, OU1, 1999.
- EPA Record of Decision, Eagle Mine, OU2, 1998.
- Gillman Townsite Recreational-Trespasser User Soil Exposure Risk Assessment, prepared by Morrison Knudsen (MK) and ICF Kaiser, February 11, 1997.
- EPA Record of Decision, Eagle Mine (OU1, 1993).
- Risk Assessment for Maloit Park Wetlands and Screening-Level Assessment for Selected Study Areas, prepared by USEPA, July 30, 1993.
- Health Assessment for Eagle Mine, prepared by CDH, March 1, 1989.
- Risk Assessment for Metals Exposure at the Minturn Middle School, prepared by Slosky & Company, August 7, 1989.
- Endangerment Assessment, prepared by State of Colorado, May 20, 1988.

Interviews were conducted with the following individuals to provide supplemental technical information:

- Michael Holmes - EPA
- Wendy Naugle - CDPHE
- Joe Trujillo - Frank Environmental Services, contractor to CBS

Data Review

The Eagle Mine remedy was designed principally to reduce metals loading to the Eagle River. An extensive monitoring program has been conducted. Environmental monitoring data collected and evaluated during this review period include:

- Surface water quality
- Biological (macroinvertebrates and brown trout)
- Ground water quality
- Settlement
- Erosion
- Water Treatment Plant effluent water quality
- Mine water level
- Liberty Mine Water Quality and pumping rates

Surface Water Quality Data Review

Surface water quality monitoring is the key component of environmental monitoring at the Eagle Mine Site. One way to measure the success of remedial actions is to review long-term trends in water quality. Extensive Site studies have indicated that while other metals are present in surface water, zinc occurs in the highest concentrations and other metals (with the possible exception of copper) show a high degree of correlation with dissolved zinc concentrations in surface water. Also, while surface water quality is measured at multiple locations throughout the Site, the variations in water quality at each location are similar. Therefore, one monitoring location, E-12A is selected to depict the long-term Site water quality trend for this report. This station is located on the Eagle River, just below Rex Flats (see Figure 2 in Attachment A).

This location is near the downstream end of the Site, below all significant contributors of metal load. As shown in Figure 3 (Attachment A), response actions have significantly improved water quality. Figure 3 also shows a strong seasonal trend related to early spring snow melt prior to high flows during peak runoff.

Dissolved zinc load, measured as pounds/day (lbs/day), is used to assess remaining sources of contamination and to measure improvements in contaminant reduction. In recent years zinc load is calculated for each monitoring station during September and October, when the flow at each station can be measured manually. However, as previously discussed, water quality during March and April is of primary concern. Therefore, an estimate was made of metal loading during this critical period. The results of this exercise were published in a report on Metals Loading and Water Quality Standards Attainability (CDPHE, 2008).

The average load contribution for the Eagle River by reach is summarized on Figure 4 (Attachment A), for the period March and April of 2002 through 2007.

Although the method of load estimation during this period may introduce certain error associated with the way in which flows were derived (see CDPHE, 2008 for more detail), it is clear that zinc loads are dominated by sources in the Belden Reach and Rock Creek.

Biological Data Review

Specific metrics used to define a healthy biological community were negotiated among EPA, the State and Viacom (and binding on CBS) and summarized in a March 2004 Biological Approach Document (CDPHE/EPA, Approach to Defining "Healthy" Biological Community, Final, March 2004). These metrics include comparing brown trout total density and their prey base at the Site against reference sites. Spring densities of brown trout at the Site were to be equal to or greater than 95% of the mean of the population densities at the reference sites for three consecutive years. Macroinvertebrates were evaluated using metrics collectively referred to as the "Benthic Index of Biotic Integrity."

In 2004, neither the brown trout metrics nor the macroinvertebrate metrics were attained for three consecutive years at all sampling locations, as required by the Biological Approach. As a result, an Investigative Study was conducted. The study concluded:

> *….zinc continued to have negative impacts to brown trout populations and site attainment, even after accounting for these negative effects of peakflow. These findings are not surprising, given that zinc concentrations during spring snowmelt season are still above concentrations suggested by hardness-based LC50 equations for brown trout at some mine sites.*

Although several pilot tests have been conducted to evaluate further metals load reduction, water quality has remained relatively consistent since the publication of the 2005 Five-Year Review Report. Therefore, the above conclusions remain valid in 2008.

This biological approach was originally intended to lead to the setting of protective water quality standards. The ambient water quality at the time of attainment would be considered protective. However, it was recognized that this approach would delay the setting of WQS for up to ten years. As discussed further in Section VII, EPA's Recalculation Procedure was used to set WQS.

Water Treatment Plant Data Review

Based on EPA's Enforcement & Compliance History Online (ECHO) reports, for the three years ending in December 2007, no effluent permit compliance violations were reported.

Ground Water at CTP, OTP and Rex Flats

Three monitoring wells have been selected for this report to graphically illustrate changes in water quality over time (one each from the CTP, OTP and Rex Flats areas).

Well ET-1 is located on the east side of the CTP, OTP-MW2 is located on the east side of the OTP and REX-MW2 is located in the northwest corner of Rex Flats (see Figure 1 in Attachment A for well locations). The dissolved zinc concentration trends in each of these three wells are shown on Figure 5 (Attachment A).

Since the completion of the CTP cap in 1996, the zinc concentration in ET-1 has declined over 90%, to less than 50 mg/L. In addition, piezometer data suggest a gradual decline of the perched water table in the tailing as the CTP continues to dewater and the CTP cap limits infiltration.

Dissolved zinc in well OTP MW2 has decreased by over 90% since 1993 as a result of source removal activities at the OTP. Zinc concentrations in ground water at this location, while once greater than 1,200 mg/l, are now consistently below 10 mg/l.

At Rex Flats, zinc concentrations in ground water have not improved to the degree achieved at either the CTP or the OTP. During this Five-Year Review period, zinc concentrations at REX MW2 have been consistently below 100 mg/l.

Ground Water at Belden and Gilman

Since 1998, the Responsible Party has put forth a concerted effort to maintain the mine pool at the lowest possible elevation. A mine pool elevation of between 8,445 and 8,455 feet (mean sea level or msl) is targeted. Actual mine pool elevation during the reporting period (2006-2007) ranged from 8,472.59 to 8,431.49 feet msl. At the target level, only Adit #5, Adit #6, Ben Butler and Tip Top bulkheads back up water and many of the historical seeps near Rock Creek no longer flow. Maintaining a lower mine pool results in benefits to the environment including a decrease in the amount of seepage reaching Rock Creek and likely improvements in water quality in the Belden area.

The Liberty Well also has a significant impact on both mine pool level and volume of water requiring treatment at the WTP. Liberty Well discharge to Willow Creek, 30 to 90 gpm, is measured by a totalizing flow meter in the pump house. Flow and water quality are monitored per a minimal discharge permit from CDPHE (CDPS Permit COG6000181.) Monthly water quality samples were collected and no violations were reported. The amount of water pumped annually from the Liberty Well, representing gallons of water that do not require treatment, a significant measure of pollution prevention, is provided in Table 6.

Table 6 - Gallons of Water Pumped at the Liberty Well

2006	102,870,000
2007	150,000,000

CTP Settlement and Erosion Data

Under an Environmental Monitoring Plan (EMP, Dames & Moore, 1989), surface monuments were to be surveyed (beginning in 1997) and ten erosion monuments were to be visually inspected annually for 15 years unless either of the following criteria was met:

- Settlement within 10 percent of the estimated total settlement after cover placement.
- Eagle River water quality objectives (as described in the 1988 CD/RAP) were met.

In 2001, after no significant settlement had occurred over the previous five-year period, CDPHE and EPA approved a change in monitoring frequency to once every five years to coincide with the CERCLA Five-Year Review process.

The last settlement survey event was conducted in 2005. Therefore, no settlement data were collected during the review period for this Five-Year Review.

Erosion monuments and surrounding areas were visually inspected in June 2006, April 2007 and November 2007. No outward sings of erosion damage to the cap or damage to the cap vegetation were noted (NewFields, 2007).

Observations of the cap condition made during the April 2008 Site Inspection are discussed below.

Site Inspection

The Site Inspection was performed on April 29, 2008, by the following personnel:

- Michael Holmes, EPA Remedial Project Manager
- Wendy Naugle, CDPHE Remedial Project Manager
- Rebecca Anthony, CDPHE Water Quality Division
- Kenneth Napp, HDR Engineering, Inc.

The purpose of the Site Inspection was to observe the current Site condition and remedy elements. Snow cover prevented observation of certain remedy elements in the Rock Creek drainage. Most other remediation surface features were accessible. Subsurface features such as ground water collection trenches/wells, pumps, bulkheads, pipelines etc. were not subjected to inspections. Observable remedy elements are described below.

Wastewater Treatment Facility – A tour of this facility was provided by Joe Trujillo, the facility operator. The plant was in operation at the time of the inspection and appeared to be in good condition. A photograph of the equalization basins is provided in Attachment B (Photo No. 1).

Maloit Park – This remediated mine waste feature has a well established vegetative cover. Recent snow melt resulted in swampy conditions on the day of the inspection (Photo No. 2– Attachment B).

CTP – Vegetative cover appeared in good condition. Excessive settlement has resulted in a pronounced swale containing standing water in the southwest portion of the cover just north of the Temporary Cell (Photo No. 3– Attachment B).

The geomembrane liner component of the Temporary Cell appeared to be floating on the surface of impounded water (Photo No. 4 – Attachment B). A photograph of the water treatment plant sludge disposal cell on the CTP (Photo No. 5) is provided in Attachment B.

OTP/Rex Flats – The OTP appeared to have limited vegetative cover and was in a swampy condition due to rapid melting of the winter snowpack (Photo No. 6 – Attachment B). Rex Flats appeared to have more established vegetation and was also very wet. Seepage of acid mine drainage was apparent in a ditch at the extreme southeast corner of the OTP where a limited amount of mine waste remains underneath large boulders (Photo No. 7 – Attachment B).

Belden – No discrete surface remediation features exist in Belden other than evidence of selected mine waste removal. Photographs of Belden are provided in Attachment B (Photos 8, 9 and 10).

Rock Creek – Much of the Rock Creek drainage was inaccessible due to deep snowpack. However, the Waste Pile #8 runoff/seepage diversion ditch was observed to be receiving water from ponds impounded by beaver dams. The beaver dam(s) can be seen in the extreme lower left corner of Photo No. 11 (Attachment B).

Gilman – The Gilman Townsite was observed from State Highway (SH) 24 (Photo No. 11 – Attachment B). Site security is reported to consist of a locked gate at the access point from the SH to the Townsite.

VII. Technical Assessment

Question A: Is the Remedy Functioning as Intended by the Decision Documents?

The decision documents for the Site include:

- 1993 OU1 ROD
- 1998 OU2 ROD
- 1999 ESD

Remedy elements identified in the decision documents are summarized below by OU. An assessment of remedy element functionality is also provided.

OU1

1. Installation of a system to collect additional mine seepage along Rock Creek.

   This remedy element was constructed and operated in accordance with the ROD. However, as the mine pool has been lowered, many of the seeps have dried up and collection is no longer necessary.

2. Diversion of Rock Creek upgradient of contaminated mine seepage.

   This remedy element is constructed and functioning as intended.

3. Revegetating the area of Roaster Pile 1 (RP1) and associated drainage, and monitoring of seep water quality below the RP1 area.

   In 2004, it was determined that the revegetation in the area of Roaster Pile 1 was successful and satisfied the required revegetation criteria. In addition, monitoring of the seep below RP1 was discontinued after it was determined that this seep was no longer contributing appreciable load to the Eagle River. (Concentrations had dropped from over 90 mg/l to less than 3 mg/l with very low flow. Load diagrams from Annual Reports prior to 2005 indicated load less than 0.6 lbs/day.)

4. Surface water runoff and ground water monitoring at the waste rock piles, leachability tests on the waste rock, with evaluation of data for possible further action.

   Surface and ground water monitoring is being conducted. However, a formal CMP has not been prepared or implemented. This is largely due to the necessity for the CMP to address final water quality standards for the Eagle River set during the June 2008 meeting of the Colorado WQCC. It is anticipated that the CMP will be prepared under a CD to be negotiated in the near future.

Leachability studies on individual waste rock piles have been completed. The results of the leaching study led to the construction of two leachate collection systems below Waste Rock Pile 8. The results will also be considered in connection with potential further response actions, monitoring, and maintenance at the Site.

5. Development of an inspection and maintenance plan to ensure the long-term integrity of structures and facilities associated with the Eagle Mine.

   O&M at the Site is currently governed by the Inspection and Maintenance Plan ("IMP"), dated 1997, approved under the CD-SOW. This plan requires updating.

6. Implementation of use restrictions for ground water at Rex Flats and OTP and accelerated revegetation at Rex Flats.

   Use restrictions for ground water were not implemented and therefore is not functioning as intended. However, at the time of this Five-Year Review, new water wells are not know to have been constructed since the time of the ROD (other than for ground water monitoring).

   Rex Flats has been revegetated.

7. Rapidly complete the cap on the CTP, drain and cap the historic pond, extract and treat leachate/ground water from the CTP extraction trenches, enhance CTP extraction trenches, construct a new up-gradient ground water diversion structure and relocate the Town of Minturn drinking wells.

   This remedy element is constructed and largely functioning as intended. During the Site Inspection (Section VII) two deficiencies were noted including excessive local settlement resulting in water ponded on the cap and damage to the geomembrane component of the temporary cell portion of the CTP. Although the temporary cell was not explicitly required under the OU1 ROD, it is a component of the CTP.

8. Continue the treatment of contaminated mine seepage and leachate/ground water from the CTP at the Water Treatment Plant until Site cleanup goals can be met without such treatment, dewater treatment sludge and dispose of the sludge in on-site lined cells on the CTP.

   This remedy element has been implemented and is functioning as intended. Operation and maintenance of the CTP ground water extraction system and Water Treatment Plant is required by the CD/SOW for a period not to exceed ten years after the effective date of the CD/SOW, or June 12, 2005, or less, if the PRP can demonstrate to the satisfaction of EPA and CDPHE that the ground water extraction system is no longer needed to meet water quality criteria.

This language unrealistically allowed the cessation of WTP operations in 2005. However, CBS continued to operate the WTP through this Five-Year Review period and an up-to-date CD will be necessary to address the continued operation of the WTP and the many other activities required for the Site in the short term and long term.

9. Remove the contaminated soils and sediments from the Maloit Park Wetlands, control seepage from the CTP, and rapidly add topsoil and revegetate.

    This remedy element is constructed and functioning as intended.

10. Conduct regular monitoring of surface water, ground water, mine pool, and biota at key locations on the Site and downstream of the Site to determine progress towards cleanup goals.

    This monitoring is occurring. However, a formal CMP has not been prepared or implemented. This is largely due to the necessity for the CMP to address final water quality standards for the Eagle River set during the June 2008 meeting of the Colorado WQCC. It is anticipated that the CMP will be prepared under a CD to be negotiated in the near future.

11. Install a well (Liberty Well) in an existing drift that connects the Eagle Mine workings to the Turkey Creek and Willow Creek watershed near Red Cliff. Discharge intercepted water to Willow Creek.

    This remedy element is constructed and functioning as intended.

The remedy for OU1 was intended to control the transport of metals from various sources to the Eagle River and to ground water. A review of historical documents, environmental data, ARARs, and results of the site inspection indicate that the remedy for OU1 is largely functioning as intended by the 1993 ROD, as modified by the 1999 ESD. Water quality in the Eagle River has improved significantly and brown trout and macroinvertebrate populations are recovering.

Formal measures of remedy performance for surface and ground water such as chemical concentrations at points of compliance (POC) have not been established. It is expected that such measures of performance as well as an expected time-frame for compliance will be defined in a CMP to be developed and incorporated into a CD.

OU2

1. An IC to provide a mechanism for informing EPA and the State of Colorado of any proposed change in land use.

    This remedy element was not formally implemented. However, prior to conducting any work in Gilman, the property owner interested in developing the Site, the Ginn Entities, contacted both EPA and the State of Colorado.

2. An IC to require any future developer to identify risks to human health and the environment from any land disturbance and eliminate, mitigate or control such risks during and after development.

   This remedy element was not formally implemented. However, the only known developer interested in portions of the Site (Ginn Entities) is complying with this remedy element in cooperation with EPA and CDPHE.

3. Limited Site security by maintenance of a locked gate at the roadway access to Gilman.

   This remedy element was reported by EPA to be implemented and maintained.

Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and Remedial Action Objectives (RAOs) Used at the Time of the Remedy Selection Still Valid?

Exposure Assumptions and Toxicity Data

Risks to humans and the aquatic environment were evaluated in multiple documents rather than consolidated in a single baseline risk assessment. These documents and associated exposure assumptions and toxicity factors are discussed below by receptor.

Human Health

As discussed in Section III, multiple semi-quantitative and quantitative risk assessments were performed. Of these, many addressed portions of the Site that have subsequently undergone active remediation (e.g. OTP, Maloit Park, etc.). Therefore, the conclusions reached in these documents are no longer relevant and were not examined as part of this Five-Year Review.

Human health risks associated with metals in soils and/or mine wastes were evaluated quantitatively for the Minturn Middle School and Gilman. Neither area was subsequently subjected to active remediation. Therefore, the risk assessments associated with these two areas were examined as part of this Five-Year Review to determine if the risk estimates remain valid. The relevant documents include:

- Gilman Townsite Recreational-Trespasser User Soil Exposure Risk Assessment (1997)
- Risk Assessment for Metals Exposure at the Minturn Middle School (1989)

Certain inputs to risk calculations have changed since the Minturn Middle School and Gilman risk assessment were performed. These changes are summarized below and detailed in a memorandum provided as Attachment C.

Gilman Risk Assessment:

- The Exposure Point Concentration (EPC) for lead was the 95% upper confidence limit (UCL) of the mean concentration. EPA guidance recommends use of the arithmetic mean as the EPC.
- The values for the baseline blood lead level in adults (PbB0) and the geometric standard deviation of blood lead levels in adults (GSD) model parameters have changed since the 1997 assessment.

- The acute oral RfD for arsenic has been revised since the 1997 assessment.

Minturn Middle School Risk Assessment:

- The values for the soil ingestion rate and body weight exposure parameters have changed since the 1989 assessment.
- Most of the toxicity values have changed since the 1989 assessment.

Recalculation of Site risks in accordance with current EPA guidance and using the original chemical concentration data was performed. This work is detailed in Attachment C and concludes that concentrations of metals that remain in surface soil at the Gilman Townsite are protective of human health (under a trespasser exposure scenario), with the exception of concentrations of lead in waste rock areas. Further, the levels of contaminants in surface soil at Minturn Middle School are protective of human health (the child student), with estimated risks that are within or below EPA's target risk range for cancer (1E-06 to 1E-04) and noncancer (HI<1E+00) effects.

The remedy selected for OU2 included ICs to restrict trespasser access to contaminated areas of Gilman. This remedy, if implemented effectively, addresses unacceptable risks associated with lead at Gilman. The effectiveness of the OU2 remedy is discussed under "Question A" in this Section of the Five-Year Review Report.

Aquatic Life

The most recent evaluation of risk to aquatic life was published in:

- Factors Influencing Brown Trout Populations in Mine-impacted Reaches of the Eagle River following Remediation Efforts (2005)
- Biological Monitoring Report for the Eagle Mine Superfund Site 1990-2005 (2005)

Exposure assumptions and toxicity data used in the preparation of these reports remains valid.

Cleanup Levels

Cleanup levels at the Site are a combination of chemical-specific ARARs (surface and ground water) and risk-based concentrations (soils/mine waste).

ARAR-Based Cleanup Levels

Surface Water:

The 1993 ROD lists the Colorado Classifications and Numeric Standards for Surface Water, 5 CCR 1002-33, as applicable or relevant and appropriate to Site surface waters. This regulation classifies the relevant segments of the Eagle River (segment 5) and Cross Creek (segment 7) impacted by the mine as cold water aquatic life I, and establishes hardness-based Table Value Standards (TVS) for physical and biological parameters, inorganic compounds, and metals.

The ROD adopted the chronic TVS as the surface water quality Final Remedial Action Goals and calculated contaminant-specific ARARs using a hardness of 100 mg/l (Table 7).

Table 7 - Table Value Standards Listed in the OU1 ROD

Zinc	117 ug/l	106/ug/l
Cadmium	3.9 ug/l	1.1 ug/l
Copper	18 ug/l	12 ug/l
Lead	96 ug/l	4.0 ug/l
Silver	2.0 ug/l	0.08 ug/l

Note that some of the formulas used to calculate these standards have been revised since the publishing of the ROD.

Colorado surface water regulations authorize the WQCC to adopt site-specific standards to apply in lieu of statewide TVS. At the time the ROD was being drafted, Segment 5 of the Eagle River had seasonal temporary modifications applicable for copper and zinc that were less stringent than TVS. The OU1 ROD recognized that these temporary modifications were not appropriate remediation targets and instead selected the TVS in Table 8 as surface water ARARs. The ROD allows for these ARARs to change once the WQCC "formally redefines the nature of the aquatic community being protected and the numeric standards required to protect that redefined aquatic community." This determination was made by the WQCC in the June 2008 rulemaking described below, and the new standards become the new surface water ARARs guiding future negotiations with CBS for additional remedial work.

Following the December 2005 rulemaking hearing, the WQCC divided Segment 5 of the Eagle River into three smaller segments (5a, 5b, and 5c), as well as Cross Creek (7a and 7b), and adopted revised site-specific seasonal temporary modifications to address elevated levels of zinc during certain times of the year while allowing copper temporary modifications to expire. The revised zinc modifications expire on 1/1/09 and are presented in Table 8, below (values correspond to the acute/chronic standards measured in ug/l):

Table 8 - Seasonal Zinc Standards

5a	472/410	178/166
5b	332/310	153/123
5c	275/257	127/TVS
7b	254/193	120/116

The WQCC considered various proposals for permanent standards on these segment at the June 2008 rulemaking hearing. EPA and CDPHE proposed eliminating the temporary modifications as well as changes to the Zinc, Copper and Cadmium standards based on EPA's recalculation procedure. The goal of this procedure is to establish concentration limits protective of resident species in the specific water body, and results in a hardness-based equation as the actual standard rather than a specific numeric standard (Table 9).

These standards are, in most cases, less stringent than TVS, yet reflect attainable levels of these three metals considering the anticipated reduction in loading following future remedial work.

Table 9 - EPA/State Proposed Water Quality Standards for June 2008 Rulemaking Hearing

Segment	*Zinc*	*Copper*	*Cadmium*
5a	Ac=0.978*$e^{0.8537[\ln(\text{hardness})]+2.1302}$ Ch=0.986*$e^{0.8537[\ln(\text{hardness})]+1.9593}$	Ac=0.96*$e^{0.9801[\ln(\text{hardness})]-1.1073}$ Ch=0.96*$e^{0.5897[\ln(\text{hardness})]-0.0053}$	Ac=TVS Ch=1.101672[(ln (hardness) *0.041838)]* $e^{(0.7998\ [\ln \text{hardness})]-3.1725)}$
5b	January 1 through April 30th: Acute=0.978∗$e^{0.8537[\ln(\text{hardness})]+2.1302}$ Chronic=0.986∗$e^{0.8537[\ln(\text{hardness})]+1.9593}$ May 1 through December 31st: Acute=0.978∗$e^{0.8537[\ln(\text{hardness})]+1.4189}$ Chronic=0.986∗$e^{0.8537[\ln(\text{hardness})]+1.2481}$	Ac=0.96*$e^{0.9801[\ln(\text{hardness})]-1.5865}$ Ch=0.96*$e^{0.5897[\ln(\text{hardness})]-0.4845}$	Ac=TVS Ch=1.101672 [(ln(hardness)*0.041838)] * $e^{(0.7998\ [\ln \text{hardness})]-3.1725)}$
5c	Ac=0.978*$e^{0.8537[\ln(\text{hardness})]+1.4189}$ Ch=0.986*$e^{0.8537[\ln(\text{hardness})]+1.2481}$	Ac=0.96*$e^{0.9801[\ln(\text{hardness})]-1.5865}$ Ch=0.96*$e^{0.5897[\ln(\text{hardness})]-0.4845}$	Ac=TVS Ch =1.101672 [(ln (hardness)*0.041838)]* $e^{(0.7998\ [\ln \text{hardness})]-3.1725)}$
7b	January 1 through April 30th: Acute=0.978∗$e^{0.8537[\ln(\text{hardness})]+2.1302}$ Chronic=0.986∗$e^{0.8537[\ln(\text{hardness})]+1.9593}$ May 1 through December 31st: Acute=0.978∗$e^{0.8537[\ln(\text{hardness})]+1.4189}$ Chronic=0.986∗$e^{0.8537[\ln(\text{hardness})]+1.2481}$	Ac=0.96*$e^{0.9801[\ln(\text{hardness})]-1.5865}$ Ch=0.96*$e^{0.5897[\ln(\text{hardness})]-0.4845}$	Ac = TVS Ch =1.101672 [(ln (hardness)*0.041838)]* $e^{(0.7998\ [\ln \text{hardness})]-3.1725)}$

Ground Water:

The Basic Standards for Ground Water, 5 CCR 1002-41, are listed as relevant and appropriate for Site groundwater. The Basic Standards for Ground Water rely upon a scheme for classifying groundwater based on a use, however, none of the groundwater at the Site has been classified. Nonetheless, when the EPA ROD was published in 1993, groundwater classification was assumed for each area of the Site based on-site-specific conditions. Maloit Park North of Cross Creek groundwater was listed as Class 1 (Domestic Use Quality), groundwater Beneath the CTP was listed as Class 4 (Potentially Usable Quality), Rex Flats groundwater and groundwater adjacent to the Eagle River were listed as Class 3 (Protection of Surface Water), and the OTP groundwater was listed as Class 5 (Limited Use and Quality).

In 1994, after the publication of the ROD, the Colorado WQCC adopted a new method of applying groundwater standards in the absence of a site-specific classification promulgated by the WQCC called the Interim Narrative Standard (INS). The INS requires that for unclassified groundwater, the most stringent of the standards listed in Regulation 41 are applicable. As such, the currently applicable groundwater standards are:

- Arsenic 10 ug/l
- Cadmium 5 ug/l
- Chromium 100 ug/l
- Lead 50 ug/l
- Mercury 2 ug/l

Of these standards, the only changed value since the 2005 review is the standard for Arsenic. The WQCC elected to adopt EPA's maximum contaminant level for Arsenic as Domestic Water Supply – Human Health Standards, promulgated in Table 1 of 5 CCR 1002-41, following a December 2007 rulemaking.

Risk-Based Cleanup Levels

Surface Soils/Mine Waste:

Risk-based clean-up levels were identified in the OU1 ROD as well as subsequent documents related to remedial design. These risk-based cleanup levels include:

- Arsenic - A cleanup level for this chemical was established only for Maloit Park at 500 mg/Kg. This risk-based clean-up level is protective for the trespasser (current exposure scenario).
- Cadmium - A cleanup level for this chemical was established only for Maloit Park at 30,800 mg/Kg. This value is equivalent to a non-cancer Hazard Quotient of 2 for the chronic RME trespasser scenario but is equivalent to 1 or less for acute, subchronic and Central Tendency Estimate (CTE) chronic exposure. Therefore, this value is considered to be marginally acceptable for the trespasser (current exposure scenario).
- Chromium - A cleanup level for this chemical was established only for Maloit Park at 153,700 mg/Kg. This risk-based clean-up level is protective for the trespasser (current exposure scenario).

- Lead - A remedial goal of 1,000 mg/Kg was set in the OU1 ROD for the Roaster Piles, OTP, Rex Flats and Pipeline/Trestle areas of the Site (see Figure 1 in Attachment A for Site features). This risk-based clean-up level is protective for the trespasser (current exposure scenario) and may be protective for other land uses. For Maloit Park, a clean-up level of 500 mg/Kg was established subsequent to the OU1 ROD. This risk-based clean-up level is also protective for the trespasser (current exposure scenario) and may be protective for other land uses.

The identification of a cleanup goal only for lead in certain portions of the Site and for other chemicals elsewhere is of potential concern. Mining-related inorganic contaminants often exist in association with one another. Therefore, it is possible that by remediating to a lead cleanup level, any other toxic metals were also addressed. The relatively conservative cleanup level for lead under a trespasser exposure scenario (1,000 mg/Kg) further suggests that this may be the case.

This potential area of concern might be resolved through recalculation of risk-based clean-up levels for a trespasser for all chemicals of potential concern. These levels would then be compared with EPCs calculated from new soil and mine waste chemical data recently collected by the Ginn Entities. These new data describe the current Site surface soil/mine waste conditions, including the post-remedial footprint of former Roaster Piles, the OTP, Rex Flats and Maloit Park. Such an exercise would provide a final check as to potential human health risks under the current land use and exposure scenario (trespasser). The Risk Assessment conducted by the Ginn Entities establishes new risk-based cleanup levels for redevelopment at the Site, based on residential use.

Remedial Action Objectives

Qualitative RAOs in OU1 ROD include:

- Improve the quality of water in the Eagle River to support a Class 1 aquatic life use.
- Control or eliminate human ingestion of contaminated ground water.
- Control or eliminate exposure to airborne contaminants.
- Control or eliminate exposure to contaminants in soil.
- Ensure the long term integrity of structures and facilities associated with remedial activities at the Site.

These RAOs remain valid.

No RAOs were identified in the OU2 ROD.

Other ARARs

The selected remedy for OU2 is institutional controls to limit site access and provide a long-term, local presence. Zoning regulations and/or building permit code restrictions were identified in the ROD as the controls.

Action and location specific ARARs were not identified for OU2, as there were no activities in the ROD to trigger action or location specific requirements.

Additionally, the ROD stated that there are no chemical specific ARARs for surface soils contamination. No chemical specific ARARs were identified for air or water.

The IC remedy included requirements where any future developer must identify risks to human health and the environment from any land disturbance and eliminate, mitigate or control such risks during and after development. The strategy also recognizes that if any land use changes and Gilman is developed for residential use, additional remediation may be required. EPA and the State will review any developer-generated assessment and land remediation plans to assure that redevelopment is protective of human health and the environment.

Environmental Covenants

The Colorado Environmental Covenant (EC) Law, C.R.S. §§ 25-15-317 to 25-15-327, requires property owners to grant an environmental covenant in conjunction with remedial activities that results in: 1) residual contamination levels that have been determined safe for some uses but not others; or 2) incorporation of an engineered feature or structure requiring monitoring, maintenance or operation that will not function properly if disturbed. The EC law will apply to the current owner of property within the Site, the Ginn Entities, if current development plans are approved and remedial activities result in one of the two scenarios described above.

The EC law was amended in April 2008 creating the "restrictive notice" as an alternative mechanism to the EC. Restrictive notices are similar to ECs with the exception that they operate as an exercise of the State's police power rather than an interest in property. As such, CDPHE may unilaterally issue a restrictive notice if a property owner fails to grant one of these two mechanisms.

Question C: Has Any Other Information Come to Light that Could Call Into Question the Protectiveness of the Remedy?

No other information has come to light during the Five-Year Review that could call into question the current protectiveness of the remedy. However, portions of the Site may be developed for residential and recreational uses. Such changes in land use (should they occur) will require modifications to Site decision documents as well as additional response actions.

Technical Assessment Summary

According to the information collected and reviewed, the remedies for OU1 and OU2 are largely functioning as intended by the RODs, Consent Decrees and subsequent ESD.

VIII. Issues

Based on the information collected during this Five-Year Review Report, the following issues are identified in Table 10:

Table 10 - Issues

Item No.	Issues	Affects Current Protectiveness	Affects Future Protectiveness
1	The two CDs currently in place effectively addressed the completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish Points of Compliance (POCs) and time frame for compliance with ARARs.	No	Yes
2	Surface water quality in the Eagle River is not protective of brown trout.	Yes	Yes
3	Institutional controls (ICs) to regulate development under existing or revised land zoning in OU1 were not required under the ROD. Such ICs are necessary to ensure the future land use is consistent with the remedy. These ICs were required under the OU2 ROD but were not formally implemented. Development of portions of OU1 and OU2 as a ski resort with residential development is proposed for implementation within the next several years. Such development will comply with the ICs.	No	Yes
4	Institutional controls prohibiting new wells required under the OU1 ROD have not been implemented.	No	Yes
5	Physical limits of OU1 and OU2 have not been defined. Therefore, the area over which OU-specific ICs apply is unclear.	No	Yes
6	Apparent excessive settlement on CTP resulting in ponded water observed during the Site inspection.	No	Yes
7	Geomembrane liner in temporary cell on CTP in poor condition.	No	Yes

Table 10 - Issues (cont'd.)

Item No.	Issues	Affects Current Protectiveness	Affects Future Protectiveness
8	The Mine at Adit #8 has partially collapsed presenting a safety hazard for personnel entering the mine.	No	No
9	Proposed redevelopment could potentially impact human health and the environment during and after implementation.	No	Yes

IX. Recommendations and Follow-Up Actions

The recommendations and follow-up actions for the issues are summarized below in Table 11:

Table 11 - Recommendations and Follow-Up Actions

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
1	The two CDs currently in place effectively addressed the completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish Points of Compliance (POCs) and time frame for compliance with ARARs established.	The State and EPA will develop a CD that updates terms, established performance standards, POC(s), ARAR compliance schedule, current/future activities, reporting requirements, schedules and any other items. These requirements will be incorporated into a Compliance Monitoring Plan (CMP).	EPA/CDPHE/CBS	EPA/ CDPHE	12/31/09	No	Yes

Table 11 - Recommendations and Follow-Up Actions (cont'd)

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
2	Surface water quality in the Eagle River is not protective of brown trout.	Revision of water quality standards through Water Quality Control Commission (WQCC) occurred in June 2008. New standards adopted by the WQCC become performance standards for the Site surface water and will be incorporated into the CD discussed in Issue No. 1. The new water quality standards will be identified as Site ARARs in an ESD or ROD Amendment. Additional response actions would be required to comply with the new performance standards and would be implemented as discussed in the Metals Loading and Water Quality Standards Attainability Analysis (CDPHE, 2008), at a minimum. Such additional response actions would be identified in an ESD or ROD Amendment and the CD discussed in Issue No. 1.	CDPHE and EPA	EPA/ CDPHE	New water quality standards - June 2008. ESD or ROD Amendment – 9/30/09 Implementation of additional response actions – To be determined and defined in the CD discussed in Issue No. 1.	Yes	Yes

Table 11 - Recommendations and Follow-Up Actions (cont'd)

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
3	Institutional controls (ICs) to regulate development under existing or revised land zoning in OU1 were not required under the ROD. Such ICs are necessary to ensure the future land use is consistent with the remedy. These ICs were required under the OU2 ROD but were not formally implemented. Development of portions of OU1 and OU2 as a ski resort with residential development is proposed for implementation within the next several years. Such development will comply with the ICs.	Prepare an ESD or ROD Amendment identifying the need for ICs and the form the ICs will take. This may include environmental covenants (Colorado Environmental Covenant Law, C.R.S. §§ 25-15-317 to 25-15-327) for areas of the Site where the land owner is willing to enter into such agreements, County ordinances or other mechanism to maximize the likelihood that appropriate government entities control and/or oversee changes in land use.	EPA/CDPHE/Minturn or Eagle County	EPA/ CDPHE	ESD or ROD Amendment – 9/30/09 Environmental Covenants – – To be determined based on land redevelopment plans. Other ICs – 12/31/09	No	Yes
4	Institutional controls prohibiting new wells required under the OU1 ROD have not been implemented.	Formalize and enforce the ICs through an Environmental Covenant.	Minturn and Eagle County	EPA/ CDPHE	12/31/09	No	Yes
5	Physical limits of OU1 and OU2 have not been defined. Therefore, the area over which OU-specific ICs apply is unclear.	Define OU boundaries through resolution of Issue Nos. 3 and 4.	EPA/CDPHE	EPA/ CDPHE	9/30/09	No	Yes

Table 11 - Recommendations and Follow-Up Actions (cont'd)

Item No.	Issues	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date	Affects Protectiveness (Y/N)	
						Current	Future
6	Apparent excessive settlement on CTP resulting in ponded water observed during the Site inspection.	Repair cover to reestablish surface drainage.	CBS	EPA/ CDPHE	12/31/09	No	Yes
7	Geomembrane liner in temporary cell on CTP in poor condition.	Repair geomembrane.	CBS	EPA/ CDPHE	12/31/09	No	Yes
8	The Mine at Adit #8 has partially collapsed presenting a safety hazard for personnel entering the mine.	The State and EPA will work with CBS to address the rehabilitation of the mine tunnel to ensure continued access to the mine workings and to allow periodic confirmatory measurements of the mine pool elevation.	CDPHE CBS EPA	EPA/ CDPHE	12/31/09	No	No
9	Proposed redevelopment could potentially impact human health and the environment during and after implementation.	The current property owner (Ginn Entities) has requested Bona Fide Prospective Purchaser Status and therefore will be required to perform additional actions at the Site to place the Site in a condition that is consistent with the intended land use. These actions will be documented under future decision documents.	CDPHE/EPA/Ginn Entities	EPA/ CDPHE	12/31/11	No	Yes

X. Protectiveness Statement(s)

The following protectiveness statements apply to OU1, OU2 and Site-wide surface water quality.

OU1

The remedy at OU1 currently protects human health and the environment through implementation of various actions to isolate contaminants from humans as well as collection and treatment of contaminated surface and ground water. However, in order for the remedy to be protective in the long-term, ICs to regulate development under existing or revised land zoning are necessary to ensure future land use is consistent with the remedy. In addition, ICs to prohibit new water wells must be formalized.

The two CDs currently in place effectively addressed completed remedial actions, but do not adequately address current/future operation, inspection, maintenance and monitoring activities nor do they establish POCs and time frame for compliance with ARARs. New CDs will have to be developed in order to ensure protection of human health and the environment in the long-term.

OU2

The remedy at OU2 currently protects human health and the environment through implementation of access restrictions and an IC in the form of a commitment by the Eagle County Sheriff's department to patrol the Gilman area and arrest trespassers. However, in order for the remedy to be protective in the long-term, ICs to regulate development under existing or revised land zoning are necessary to ensure future land use is consistent with the remedy.

Site-wide

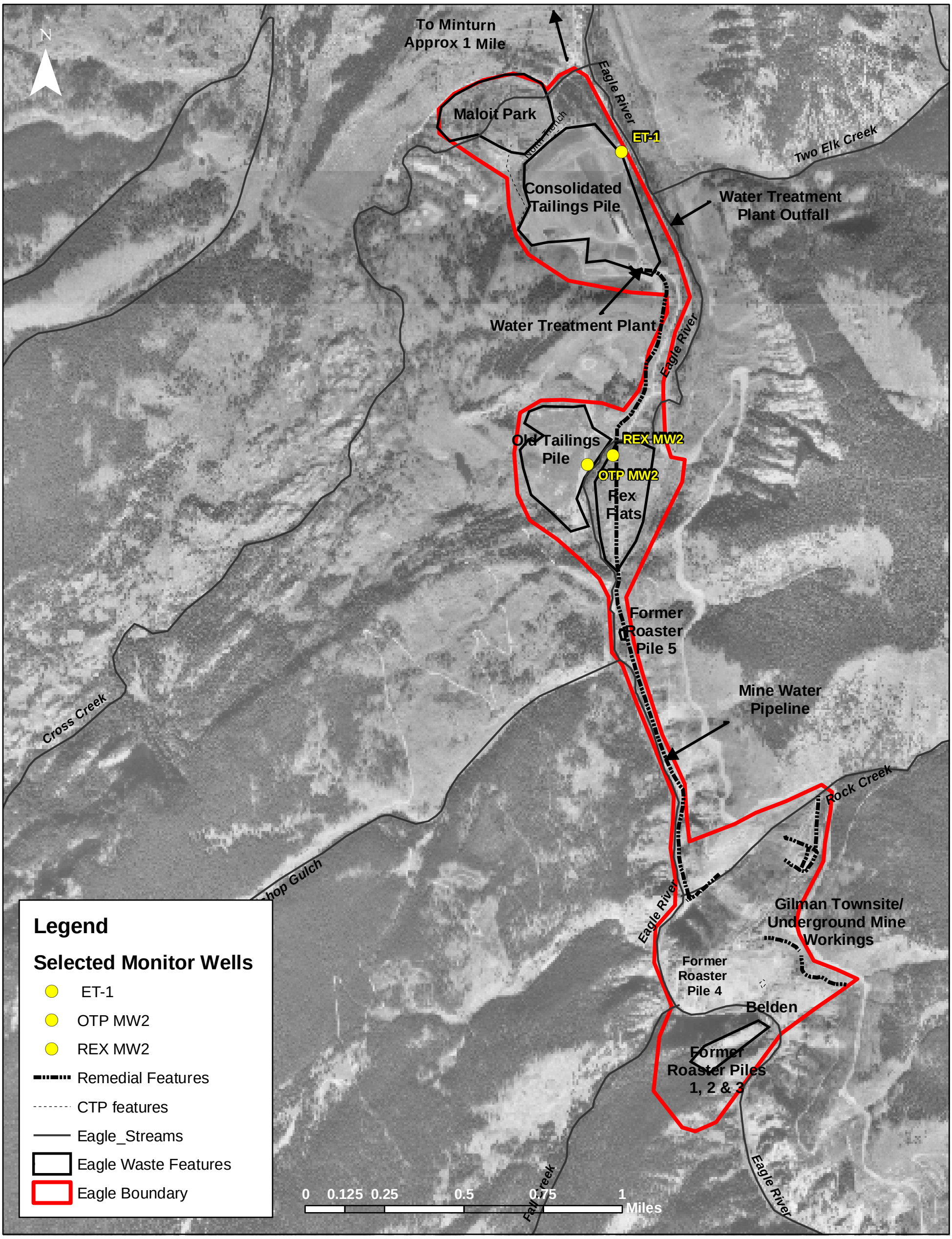
Remedy is not protective of human health and the environment because additional response actions are necessary to achieve protection of the aquatic ecosystem. New water quality standards have been adopted by the Colorado WQCC. The Site does not comply with the standards and will not comply in the future without further reductions in zinc loading through additional response actions.

XI. Next Review

The Site requires ongoing Five-Year Review in accordance with CERCLA § 121 (c). The next five year review for the Site will be performed by September 2013, five years from the date of this review.

Attachment A

Figures



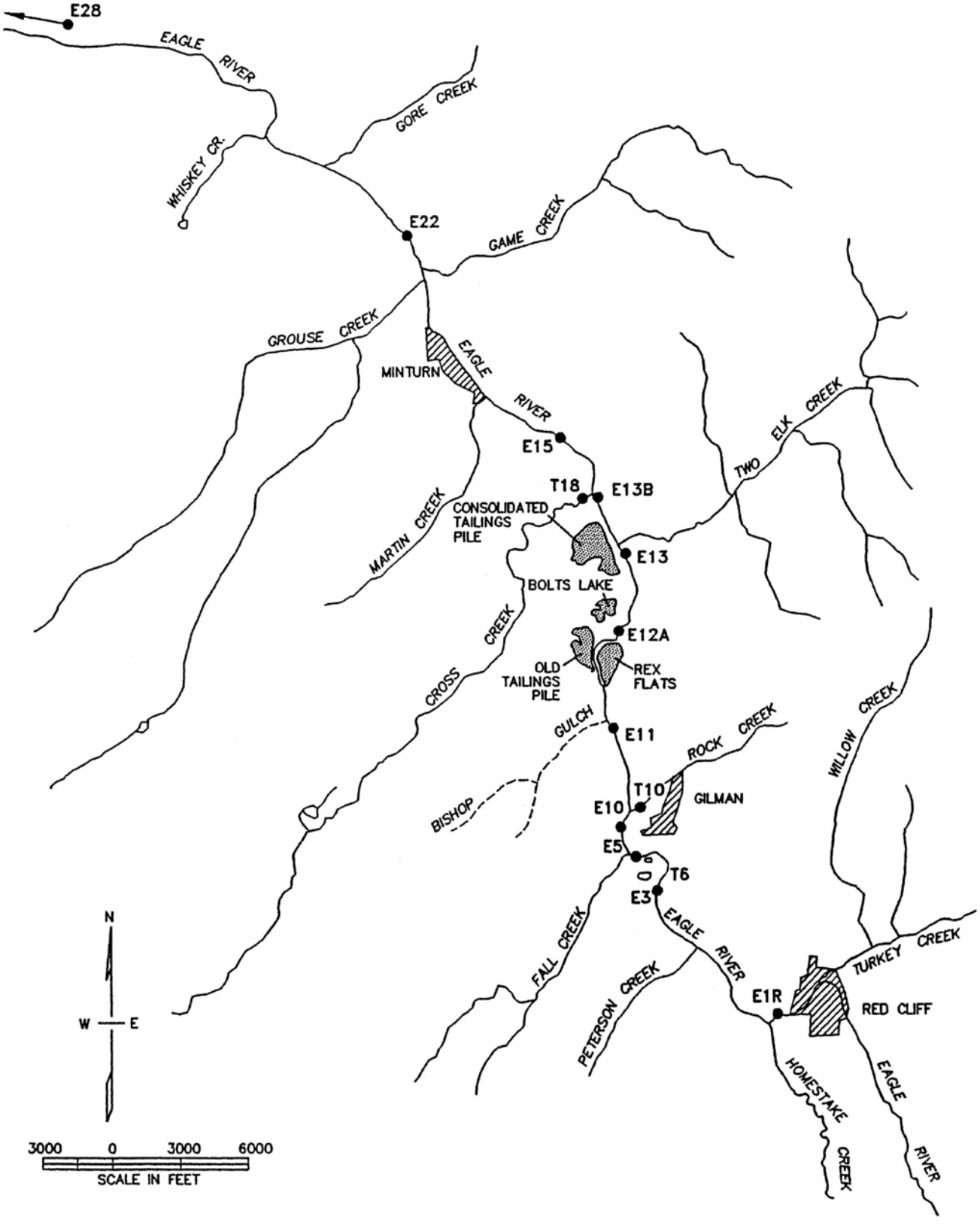
HDR

EAGLE MINE SUPERFUND SITE
SITE FEATURES

Five-Year Review
Eagle Mine Superfund Site

Date: May 2008

Figure 1



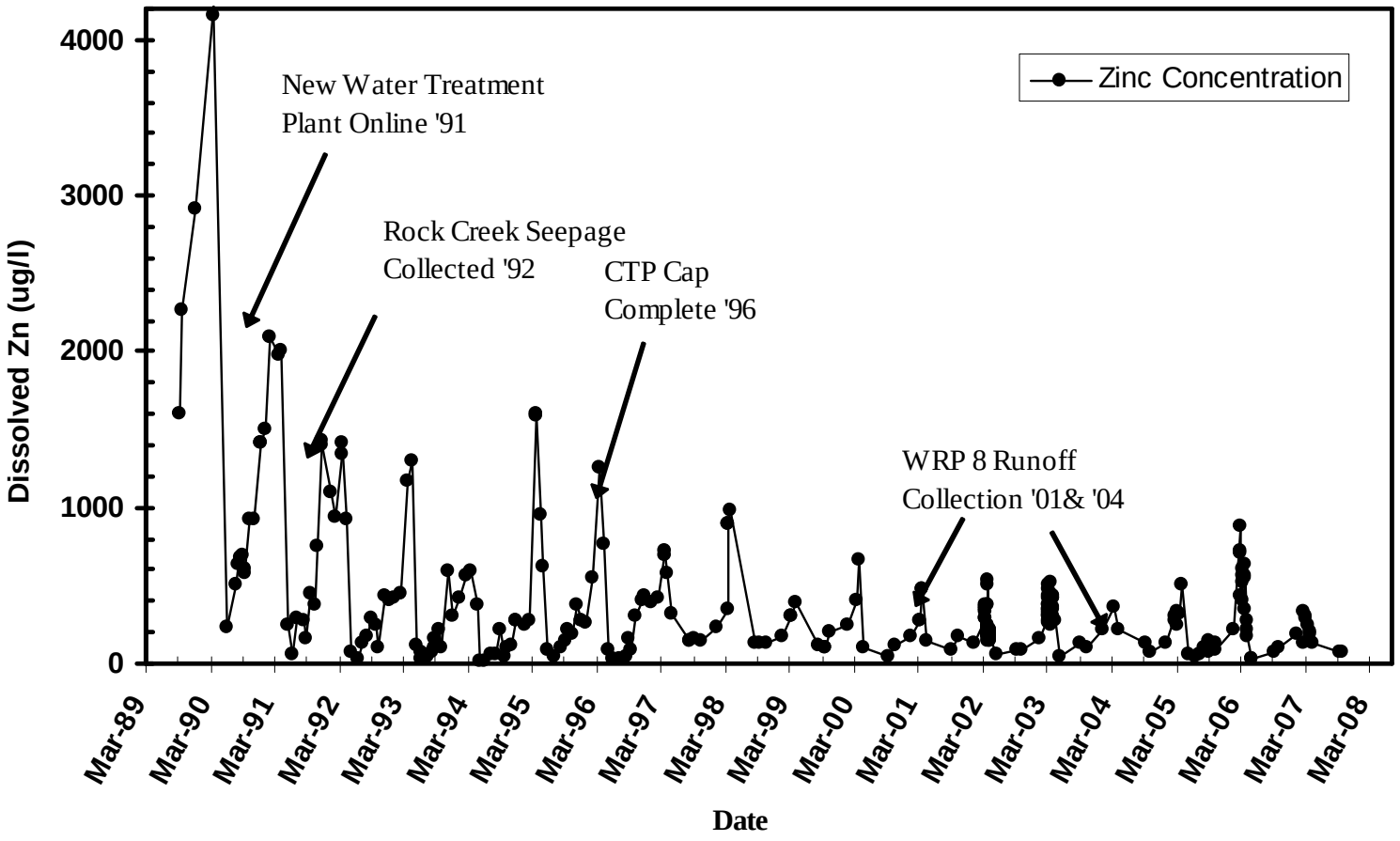
HDR

Surface-Water Quality Monitoring Locations

Five-Year Review Report
Eagle Mine Superfund Site

DATE
MAY 2008

FIGURE
2



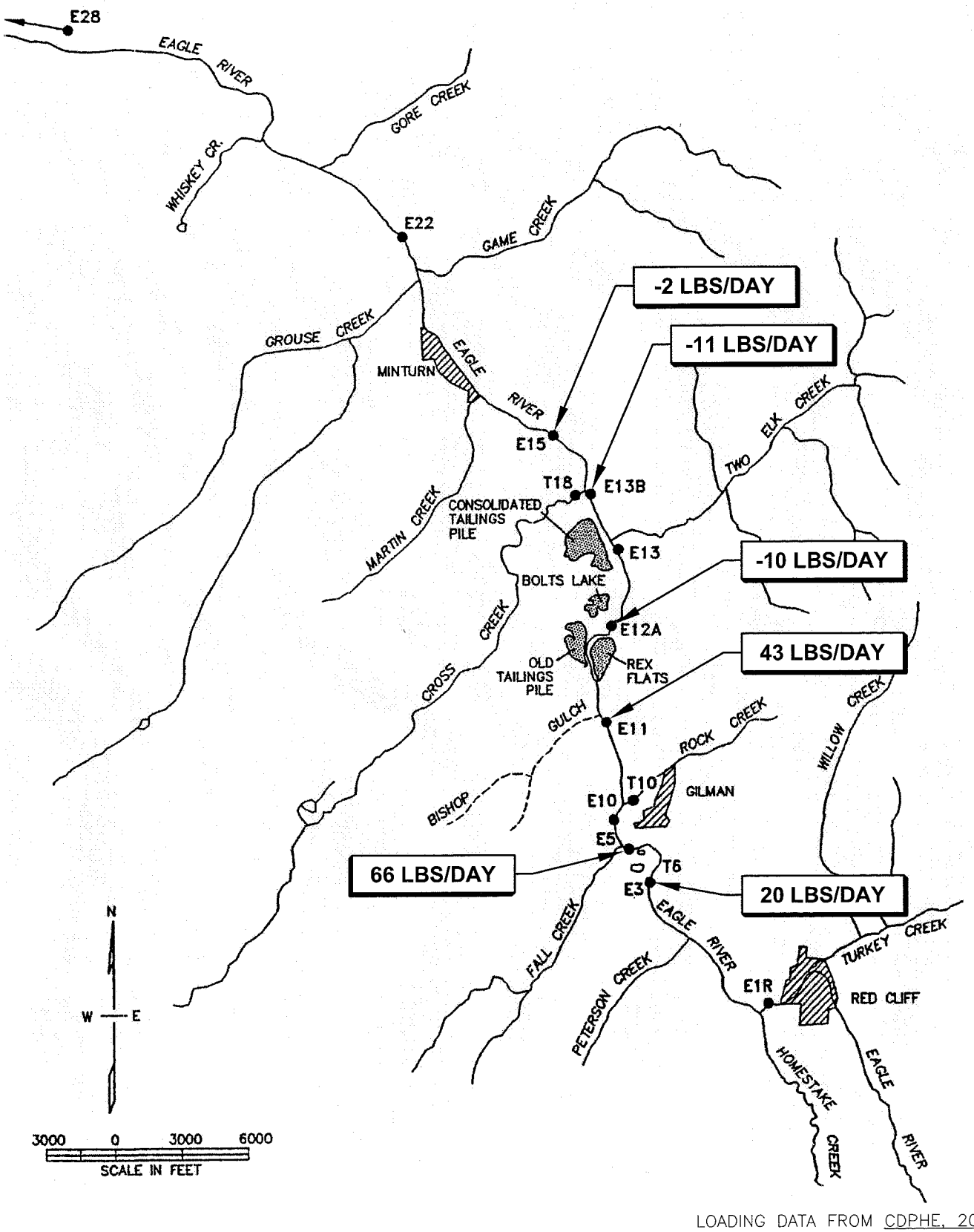
HDR

Zinc Concentration Trend at Surface Water Station E-12A

(See Figure 2 for Station Location)
Five-Year Review Report
Eagle Mine Superfund Site

DATE
MAY 2008

FIGURE
3



LOADING DATA FROM CDPHE, 2008

HDR

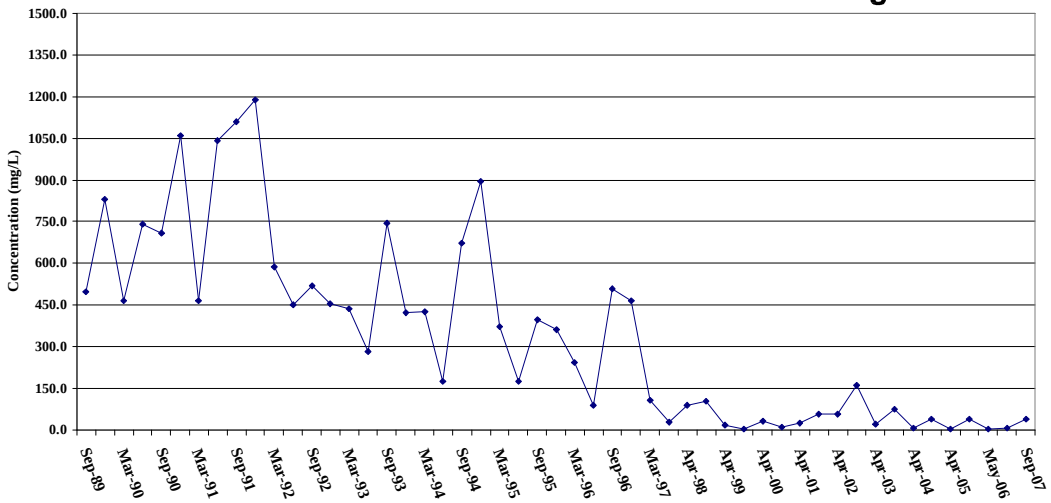
Average Daily Zinc Load Contribution by Reach for March & April 2002 to 2007

Five-Year Review Report
Eagle Mine Superfund Site

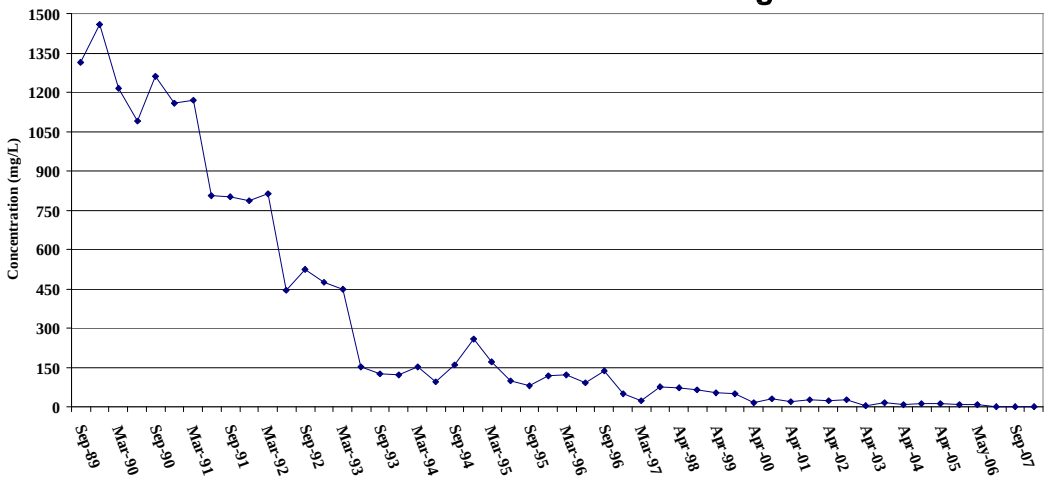
DATE
MAY 2008

FIGURE
4

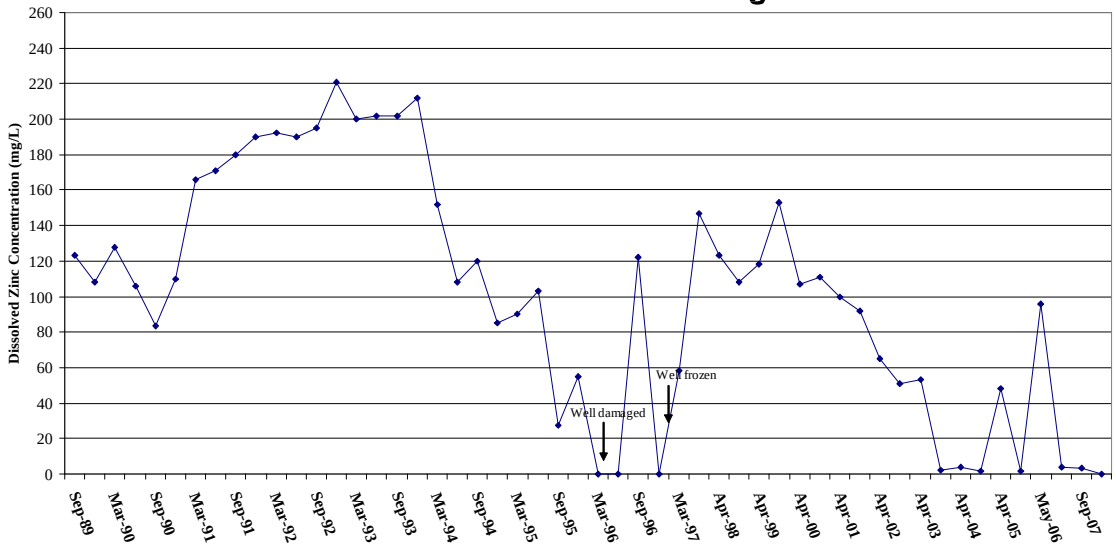
Monitoring Well ET-1



Monitoring Well MW2 at OTP



Monitoring Well MW2 at Rex Flats



HDR

Dissolved Zinc Concentration Trend in Groundwater

Five-Year Review Report
Eagle Mine Superfund Site

DATE

MAY 2008

FIGURE

5

Attachment B

Site Photographs

Photo No. 1 – Water Treatment Plant equalization basin. View to west.

Photo No. 2 – Maloit Park. View to northwest.

Photo No. 3 – Standing water in area of excessive settlement on southwest portion of CTP. View to west.

Photo No. 4 – Temporary Cell on CTP. Portion of the geomembrane liner can be seen floating on the surface. View to the west.

Photo No. 5 – Water Treatment Plant sludge disposal cell on CTP. View to north.

Photo No. 6 – View of OTP to the northwest.

Photo No. 7 – Ditch seepage from mine wastes remaining at west end of OTP. View to west.

Photo No. 8 – View to South of abandoned mine structures in Belden

Photo No. 9 – View to east of abandoned mine structures in Belden.

Photo No. 10 – View to south of cribbing near Belden.

Photo No. 11 – Gilman Townsite. View to the south. Note beaver dams in Rock Creek at lower left.

Attachment C

Risk Assessment Review Memorandum

Risk Assessment Review Memorandum
Eagle Mine NPL Site
Third Five-Year Review

This memorandum summarizes the technical findings regarding potential human health risks at the Eagle Mine Superfund Site in Minturn, Colorado. As part of the five-year review process, the following risk assessment reports were reviewed for any changes in concentrations, exposure parameters and toxicity values that may affect the protectiveness of the remedy:

- Gilman Townsite Recreational-Trespasser User Soil Exposure Risk Assessment (MK and ICF 1997)
- Risk Assessment for Metals Exposure at the Minturn Middle School (Slosky & Company, Inc. 1989).

Based on this review, concentrations of metals that remain in surface soil at the Gilman Townsite are protective of human health, with the exception of concentrations of lead in soil at waste rock areas. Further, the levels of contaminants in surface soil at Minturn Middle School are protective of human health, with estimated risks that are within or below USEPA's target risk range for cancer (1E-06 to 1E-04) and noncancer (HI < 1E+00) effects. The details of the Gilman Townsite and Minturn Middle School risk assessment reviews are summarized in the following sections.

GILMAN TOWNSITE

MK and ICF (1997) evaluated the potential acute and sub-chronic risks to an adult trespasser from the ingestion of metals in soil at two exposure units: townsite soil and waste rock areas. The study found that ingestion of non-lead chemicals (arsenic, cadmium, chromium and manganese) in surface soil from both the townsite soil and waste rock areas resulted in total noncancer Hazard Indexes (HIs) that did not exceed 1.0 (EPA's target noncancer risk level), for both acute and sub-chronic exposure scenarios. Exposure to lead was evaluated by calculating concentrations of lead in soil associated with a health-based goal (Risk-Based Concentrations (RBCs)), assuming two different soil ingestion rates (50 mg/d and 100 mg/d). The two lead RBCs were compared to the "95th UCI" (95th UCL) concentration of lead in surface soil at the townsite soil and waste rock areas exposure units. For the townsite soil exposure unit, the 95th UCI was below the RBC based on a soil ingestion rate of 50 mg/day and above the RBC based on a soil ingestion rate of 100 mg/kg. For the waste rock areas exposure unit, the 95th UCI exceeded both RBCs.

Exposure Point Concentrations

The 1997 risk assessment used 95th UCIs (95th UCLs) as the exposure point concentrations (EPCs) to evaluate potential risks from lead and non-lead chemicals.

While this approach is consistent with USEPA's recommended approach for evaluating potential risks from non-lead chemicals (USEPA 1992, 2002a), it is not consistent with USEPA's recommended approach for evaluating risks from lead (USEPA 2003a). For lead, USEPA (2003a) recommends using the average concentration as the EPC.

In this five-year review, 95th UCLs were used as the EPCs for non-lead chemicals in soil and the average concentration was used as the EPC for lead in soil. USEPA's ProUCL 4.0 software (USEPA 2007) was used to calculate 95th UCLs.

Exposure Parameters

As part of the five-year review process, the exposure parameter values were examined for any changes that may affect protectiveness. Table 1 and Table 2 compare the assumptions used by MK and ICF (1997) to current USEPA (1989, 1991 and 2003a) recommended values. As seen in Table 2, the values for the baseline blood lead level in adults (PbB0) and the geometric standard deviation of blood lead levels in adults (GSD) model parameters have changed since the 1997 assessment.

Additionally, the 1997 assessment evaluated acute and sub-chronic exposures of trespassers. In this five-year review, chronic risks were also evaluated, assuming that an adult could trespass at the Gilman townsite on a recurring basis over 2-9 years. The exposure parameters for evaluating chronic exposure are provided in Panel B of Table 1.

Toxicity Values

Toxicity values (reference doses (RfDs) and cancer slope factors (SFs)) were also examined for any changes that may affect protectiveness. Table 3 summarizes the toxicity values used in the 1997 risk assessment with current (2008) toxicity values from USEPA (2003b) recommended sources. The 1997 risk assessment derived acute and sub-chronic toxicity values from the literature for use in evaluating risks at the Gilman Townsite. To update these site-specific values, review of the scientific literature for newly published acute and sub-chronic toxicity studies would be required, which is beyond the scope of this five-year review. Instead, USEPA (2003b) recommended sources for toxicity values were examined for available peer-reviewed acute and sub-chronic toxicity values. In cases where acute and sub-chronic toxicity values were not available, chronic values were used, conservatively. This assumption is likely to overestimate acute and sub-chronic noncancer risks. As seen in Table 3 (Panel A), the acute, oral RfD for arsenic has been revised since the 1997 assessment.

The toxicity values for evaluating chronic cancer and noncancer exposures are provided in Table 3 (Panel B). The 1997 risk assessment did not evaluate a chronic exposure scenario; therefore changes in chronic toxicity values were not evaluated.

The 1997 RBA assumptions for the relative bioavailability of arsenic and other metals in soil shown in Table 3 (Panel C) are appropriate for evaluating risks to trespassers.

Results

Table 4 presents the results of the evaluation of potential risks to trespassers at the Gilman townsite. Risks from non-lead chemicals are presented in Panel A and risks from lead are evaluated in Panel B.

As seen in Panel A, acute and sub-chronic risks to a trespasser remain below a level of concern for noncancer at both exposure units, with total noncancer HI values less than 1.0 for both the acute and sub-chronic exposure scenarios. Chronic risks are also below a level of concern, with a total noncancer HI less than 1E+00 and estimated cancer risks that are within or below EPA's target risk range (1E-06 to 1E-04) at both exposure units.

As seen in Panel B, concentrations of lead in surface soil remain below both RBCs for the townsite soil exposure unit and remain above both RBCs at the waste rock areas exposure unit. These results indicate that risks are below a level of concern for a pregnant trespasser who is exposed to lead in townsite soils, whereas exposure to lead in waste rock area soils would result in the exposure of a pregnant trespasser that would be of concern to a fetus ($P10_{fetus} > 5\%$).

Based on this, the concentrations of metals that remain in surface soil at the Gilman townsite are protective of human health, with the exception of concentrations of lead in soil at waste rock areas.

MINTURN MIDDLE SCHOOL

In 1989, the Eagle County School District completed an evaluation of risks to students at Minturn Middle School (Slosky & Company, Inc. 1989) to use in deciding if the School should be used while the cleanup of the Eagle Mine Facility was in progress. The assessment evaluated students' exposure to metals in surface soil, outdoor air, indoor air and indoor dust. The estimated total noncancer Hazard Index (HI) was below a level of concern (HI < 1E+00), with a total expected noncancer HI of 4E-01. The maximum (worst case) HI was estimated to be 1.8. Cancer risks were within EPA's target risk range (1E-06 to 1E-04), with expected cancer risks of 7E-06 and a maximum (worst case) cancer risk of 4E-05.

Exposure Point Concentrations

The outdoor air and indoor dust data used in the 1989 risk assessment were collected from 1985 to 1989, before remedial actions were completed at the Site. Because these data were collected at a time when waste/tailing piles were continuing sources of particulates in air, these data are not representative of current site conditions and were excluded from the evaluation of risks to students at Minturn Middle School by this five-year review. The assumptions used to derive the exposure point concentrations (EPCs) for outdoor air, indoor air and indoor dust that were used in the 1989 risk assessment and in this five-year review are summarized in the following table:

EXPOSURE MEDIUM	1989	2008
OUTDOOR AIR	▪ Total Suspended Particulates (TSP) in air were measured at/in the vicinity of the Middle School. ▪ Concentrations of metals in TSP were assumed to be equal to the concentrations of metals in tailing/waste areas (e.g., Roster Piles, Old Tailings Pile, Rex Flats, New Tailings Pile).	▪ Concentrations of metals in outdoor air were estimated from the concentrations of metals in surface soil at the Middle School, using USEPA's (1996b) default soil-to-air Particulate Emission Factor (PEF) for wind erosion.
INDOOR AIR	▪ Concentrations of metals in indoor air were assumed to be equal to concentrations of metals in outdoor air.	▪ Concentrations of metals in indoor air were assumed to be equal to concentrations of metals in outdoor air.
INDOOR DUST	▪ Concentrations of metals in indoor dust were estimated by calculating the weighted maximum concentration of metals in dust measured inside the school and the concentrations of metals measured in surface soil at the Middle School.	▪ Concentrations of metals in indoor dust were assumed to be equal to the concentration of metals in surface soil at the Middle School.

Exposure Parameters

As part of the five-year review process, the exposure parameter values were examined for any changes that may affect protectiveness. Table 5 compares the assumptions used by Slosky & Company Inc. (1989) to current USEPA (1989, 1991 and 1997) recommended values. As seen, the recommended values for the soil ingestion rate and body weight exposure parameters have changed since the 1989 assessment.

Toxicity Values

Toxicity values were also examined for any changes that may affect protectiveness. Table 6 summarizes the toxicity values used in the 1989 risk assessment with USEPA (2003b) recommended toxicity values for use in risk assessment. As seen, most of the toxicity values have changed since the 1989 assessment. For lead, USEPA no longer utilizes slope factors to quantify potential risks from lead, but instead evaluates potential risks to children using the Integrated Exposure Uptake Biokentic (IEUBK) model and potential risks to adults using the Adult Lead Model (ALM).

Results

Risk-based concentrations were derived for metals in surface soil at the Minturn Middle School for the ingestion of surface soil and the inhalation of particulates in air (suspended from soil). These RBCs are based on a target cancer risk of 1E-04 (the upper end of USEPA's target risk range) and/or target noncancer Hazard Quotient (HQ) of 1E+00. The details of the RBC derivation are shown in Attachment 1. The RBC values are presented in Table 7 along with the concentrations of metals in surface soil reported in Slosky & Company, Inc. (1989). As seen in Table 7, both the maximum and the 95th UCL concentrations of all metals measured in surface soil at Minturn Middle School do not exceed the soil RBCs.

Thus, estimated cancer and noncancer risks to students at Minturn Middle School from exposure to metals in surface soil and air are within or below EPA's target risk range for cancer (1E-06 to 1E-04) and noncancer (total HI < 1E+00). Based on this, the levels of metals that remain in surface soil at Minturn Middle School are protective of human health.

REFERENCES

ATSDR. 2007. Minimum Risk Levels (MRLs). http://www.atsdr.cdc.gov/mrls/pdfs/mrllist_11_07.pdf, accessed May 2008.

Goyer, R.A. 1990. Transplacental Transport of Lead. Environ. Health Perspect. 89:101-105.

IRIS. 2008. Integrated Risk Information System. http://cfpub.epa.gov/ncea/iris/index.cfm

MK and ICF. 1997. Gilman Townsite Recreational-Trespasser User Soil Exposure Risk Assessment. February 11.

Pocock et al. 1983. Effects of tap water lead, water hardness, alcohol, and cigarettes on blood lead concentrations. J. Epidemiol. Commun. Health. 37:1-7.

Slosky & Company, Inc. 1989. Risk Assessment for Metals Exposure at the Minturn Middle School. August 7.

USEPA. 1989. Risk Assessment Guidance for Superfund (RAGS). Volume I. Human Health Evaluation Manual (Part A).

USEPA. 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors." Washington, DC. OSWER Directive 9285.6-03.

USEPA. 1992. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. Supplemental Guidance to RAGS: Calculating the Concentration Term. Publication 9285.7-081.

USEPA. 1994. Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities. OSWER Directive 9355.4-12. August.

USEPA. 1995. Review of a Methodology for Establishing Risk-Based Soil Remediation Goals for Commercial Areas of the California Gulch Site. Technical Review Workgroup for Lead. October.

USEPA. 1996a. Personal communication with Chris Weiss, USEPA Region VIII Toxicologist.

USEPA. 1996b. Soil Screening Guidance: User's Guide. Second Edition. Publication 9355.4-23. July.

USEPA. 1997. Exposure Factors Handbook, Volumes I, II, and III. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/P-95/002Fa.

USEPA. 2002a. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. U.S. Environmental Protection Agency, Office of Emergency and Remedial Response. OSWER 9285.6-10. December.

USEPA. 2002b. Blood lead concentrations of U.S. adult females: Summary statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). U.S. Environmental Protection Agency, Technical Review Workgroup for Lead.

USEPA. 2003a. Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. EPA-540-R-03-001. January.

USEPA. 2003b. Human Health Toxicity Values in Superfund Risk Assessments. OSWER Directive 9285.7-53. December.

USEPA. 2007. ProUCL Version 4.0. User Guide. EPA/600/R-07/038. April.

WRCC. 2008. Western Regional Climatic Center. Historical Climate Summary for Eagle Airport, Colorado. http://www.wrcc.dri.edu, accessed May 2008.

TABLES

Table 1.
Comparison of Exposure Parameters used in the Gilman Townsite Risk Assessment
used to Evaluate Risks from Non-Lead Chemicals

A. ACUTE AND SUBCHRONIC

PARAMETER	UNITS	1997				2008			
		ACUTE		SUBCHRONIC		ACUTE		SUBCHRONIC	
		VALUE	SOURCE	VALUE	SOURCE	VALUE	SOURCE	VALUE	SOURCE
Soil Ingestion Rate	(mg/kg)	100	[1, c]	100	[1, c]	100	[1, c]	100	[1, c]
Conversion Factor	(kg/mg)	1.00E-06		1.00E-06		1.00E-06		1.00E-06	
Body Weight	(kg)	70	[1, 3]	70	[1, 3]	70	[1, 3]	70	[1, 3]
Exposure Frequency	(days/yr)	7	[2, d]	14	[2, e]	7	[2, d]	14	[2, e]
Exposure Duration	(years)	0.75	[2, a]	0.75	[2, a]	0.75	[2, b]	0.75	[2, b]
Averaging Time (noncancer)	(days)	274	[3, f]	274	[3, f]	274	[3, f]	274	[3, f]

B. CHRONIC

PARAMETER	UNITS	1997				2008			
		CHRONIC				CHRONIC			
		CTE		RME		CTE		RME	
		VALUE	SOURCE	VALUE	SOURCE	VALUE	SOURCE	VALUE	SOURCE
Soil Ingestion Rate	(mg/kg)	NA	NA	NA	NA	50	[4, g]	100	[1, c]
Conversion Factor	(kg/mg)	NA	NA	NA	NA	1.00E-06		1.00E-06	
Body Weight	(kg)	NA	NA	NA	NA	70	[1, 3]	70	[1, 3]
Exposure Frequency	(days/yr)	NA	NA	NA	NA	9	[4, h]	18	[4, i]
Exposure Duration	(years)	NA	NA	NA	NA	2	[4]	9	[4]
Averaging Time (noncancer)	(days)	NA	NA	NA	NA	730	[3, f]	3,285	[3, f]
Averaging Time (cancer)	(days)	NA	NA	NA	NA	25,550	[3, f]	25,550	[3, f]

NA = Not applicable. The 1997 risk assessment did not evaluate chronic risks to trespassers.

REFERENCES:

[1] USEPA 1991
[2] MK and ICF 1997
[3] USEPA 1989
[4] Professional judgment

NOTES:

[a] Assumes total exposure duration of 9 months (period over which a female is pregnant).
[b] Assumes exposure could potentially occur during the 9 months of the year that the ground is not covered with snow (WRCC 2008).
[c] Assumes RME exposure.
[d] Assumes trespassers will visit the site 7 times over a nine-month period.
[e] Assumes trespassers will visit the site 14 times over a 3.5 month period (once a week for 3.5 months).
[f] The averaging time (days) is equal to the Exposure Duration (years) x 365 (days/year) for noncancer and 70 (years) x 365 (days/year) for cancer.
[g] Assumes CTE exposure is half of RME exposure.
[h] Assumes trespassers will visit the site 1 time per month, over a nine-month period (months when Site is not covered with snow).
[i] Assumes trespassers will visit the site 2 times per month, over a nine-month period (months when Site is not covered with snow).

Table 2.
Comparison of Exposure Parameters used in the Gilman Townsite Risk Assessment
to Derive RBCs for Lead in Surface Soil

A. RBC EQUATION (USEPA 2003a)

$$RBC = \frac{(PbB\ Goal\ (adult) - PbB0(adult)) \cdot AT}{BKSF \cdot IR \cdot AF \cdot EF}$$

where:

$$PbBGoal\ (adult) = \frac{PbB\ 95th(fetal)}{GSD^{1.645} \cdot R}$$

B. ADULT LEAD MODEL (ALM) PARAMETERS

PARAMETER	UNITS	1997		2008	
		Value	Source	Value	Source
R	(unitless)	0.9	[1]	0.9	[6, b]
GSD	(unitless)	1.8	[2, a]	2.11	[7, e]
BKSF	(ug/dL per ug/day)	0.4	[4]	0.4	[6, b]
IR	(mg/day)	50 and 100	[3]	50 and 100	[3]
AF	(unitless)	0.1	[3]	0.12	[6, b]
EF	(days/year)	90	[3]	90	[3]
PbB0 (adult)	(ug/dL)	1.8	[2, a]	1.4	[7, d]
AT	(days)	270	[3, c]	270	[8, e]
PbB 95th (fetal)	(ug/dL)	10	[2]	10	[6, 9]

References:

[1] Goyer 1990.
[2] USEPA 1996a.
[3] MK and ICF 1997.
[4] Pocock 1983.
[5] USEPA 1995.
[6] USEPA 2003a.
[7] USEPA 2002b.
[8] Professional judgment.
[9] USEPA 1994.

Notes:

[a] Assumes homogenous population.
[b] Default value.
[c] Assumes AT is 9 months (the duration of a pregnancy).
[d] Table 3a - Weighted Average for West, 17-45 years.

[e] Assumes AT is equal to the number of months that exposure could potentially occur (the 9 months of the year that the ground is not covered with snow (WRCC 2008)).

Table 3.
Acute, Sub-chronic and Chronic Toxicity Values
used in the Gilman Townsite Risk Assessment

A. ACUTE AND SUB-CHRONIC TOXICITY VALUES

CHEMICAL	1997				2008			
	NONCANCER ORAL RfD (mg/kg-day)				NONCANCER ORAL RfD (mg/kg-day)			
	Acute	Source	Sub-Chronic	Source	Acute	Source	Sub-Chronic	Source
Arsenic	1.00E-01	[1, a]	6.00E-03	[1, b]	5.00E-03	[2]	3.00E-04	[5, c; 3]
Cadmium	3.00E-01	[1, a]	1.00E-03	[1, b]	1.00E-03	[5, c; 3]	1.00E-03	[5, c; 3]
Chromium III	2.00E+00	[1, a]	1.00E+00	[1, b]	1.50E+00	[5, c; 3]	1.50E+00	[5, c; 3]
Chromium VI	7.50E-02	[1, a]	2.00E-02	[1, b]	3.00E-03	[5, c; 3]	3.00E-03	[5, c; 3]
Manganese	2.20E+00	[1, a]	2.40E-02	[1, b]	4.67E-02	[5c, 3b]	4.67E-02	[5c, 3b]

B. CHRONIC TOXICITY VALUES

CHEMICAL	1997				2008			
	NONCANCER ORAL RfD (mg/kg-day)		ORAL CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$		NONCANCER ORAL RfD (mg/kg-day)		ORAL CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$	
	Value	Source	Chronic	Source	Value	Source	Chronic	Source
Arsenic	NA	NA	NA	NA	3.00E-04	[3]	1.50E+00	[3]
Cadmium	NA	NA	NA	NA	1.00E-03	[3]	--	--
Chromium III	NA	NA	NA	NA	1.50E+00	[3]	--	--
Chromium VI	NA	NA	NA	NA	3.00E-03	[3]	--	--
Manganese	NA	NA	NA	NA	4.67E-02	[3, b]	--	--

NA = Not applicable. The 1997 risk assessment did not evaluate chronic risks to trespassers.

-- = A toxicity value is not available for this chemical from USEPA (2003b) recommended sources.

C. RELATIVE BIOAVAILABILITY (RBA)

CHEMICAL	1997		2008	
	Value	Source	Value	Source
Arsenic	0.8	[1]	0.8	[1]
All Other Metals	1.0	[4]	1.0	[4]

REFERENCES:

[1] MK and ICF 1997
[2] ATSDR 2007
[3] IRIS 2008
[4] USEPA 1989
[5] Professional Judgment

NOTES:

[a] These values were developed in consultation with USEPA Region VIII for use in evaluating the Gilman Trespassor scenario.

[b] RfDo (1.4E-01 mg/kg-day) adjusted by a modifying factor of 3, in accord with IRIS and USEPA Region 8 recommendations.

[c] Acute and/or subchronic toxicity data not available from USEPA (2003b) recommended sources. Chronic RfD was used, conservatively.

Table 4.
Results of the Evaluation of Risks to Trespassers at the Gilman Townsite

A. RISKS FROM NON-LEAD CHEMICALS

EXPOSURE UNIT	CHEMICAL	EPC (mg/kg)	NONCANCER RISK				CANCER RISK	
			acute	subchronic	chronic CTE	chronic RME	CTE	RME
Townsite Soil	Arsenic	155	7E-04	2E-02	7E-03	3E-02	9E-08	4E-07
	Cadmium	26	7E-04	1E-03	5E-04	2E-03	--	--
	Chromium III	19	4E-07	7E-07	2E-07	9E-07	--	--
	Chromium VI	4	4E-05	7E-05	2E-05	9E-05	--	--
	Manganese	12,379	7E-03	1E-02	5E-03	2E-02	--	--
Waste Rock Areas	Arsenic	1,224	5E-03	2E-01	6E-02	2E-01	7E-07	3E-06
	Cadmium	48	1E-03	3E-03	8E-04	3E-03	--	--
	Chromium III	12	2E-07	4E-07	1E-07	5E-07	--	--
	Chromium VI	2	2E-05	4E-05	1E-05	5E-05	--	--
	Manganese	9,797	6E-03	1E-02	4E-03	1E-02	--	--
TOTAL RISK	**TOWNSITE SOIL**		**9E-03**	**4E-02**	**1E-02**	**5E-02**	**9E-08**	**4E-07**
	WASTE ROCK AREAS		**1E-02**	**2E-01**	**6E-02**	**2E-01**	**7E-07**	**3E-06**

Note, chromium EPCs calculated by adjusting the total chromium concentration (14 mg/kg in waste piles, 23 mg/kg at the Townsite), assuming a 1:6 Chromium VI to Chromium III ratio in soil.

CTE = Central Tendency Exposure
EPC = Exposure Point Concentration
RME = Reasonable Maximum Exposure

B. RISKS FROM LEAD: RBCs vs SURFACE SOIL CONCENTRATIONS

EXPOSURE UNIT	VARIABLE INPUT PARAMETERS	1997		2008	
		RBC (mg/kg)	CONCENTRATION OF LEAD IN SOIL[a] (mg/kg)	RBC (mg/kg)	CONCENTRATION OF LEAD IN SOIL[b] (mg/kg)
TOWNSITE SOIL	IR = 50 mg/g	3,700	1,900	2,317	993
	IR = 100 mg/d	1,800	1,900	1,158	993
WASTE ROCK AREAS	IR = 50 mg/g	3,700	29,400	2,317	9,103
	IR = 100 mg/d	1,800	29,400	1,158	9,103

shading indicates concentrations of lead in soil that are above the RBC

Notes:

[a] Value represents the "95th UCI" (95th UCL) concentration of lead in soil.

[b] Value represents the arithmatic mean concentration of lead in soil.

Table 5.
Comparison of Exposure Parameters used in the
Minturn Middle School Risk Assessment

PARAMETER	UNITS	1989		2008	
		VALUE	SOURCE	VALUE	SOURCE
Respiraton rate (indoors)	(m^3/hr)	1	[1]	1	[3, b]
Respiration rate (outdoors)	(m^3/hr)	2.5	[1]	2.4	[3, c]
Soil Ingestion Rate	(mg/kg)	10	[1]	100	[1, d]
Conversion Factor	(kg/mg)	1.00E-06		1.00E-06	
Body Weight	(kg)	35	[1]	52.5	[3, a]
Exposure Time (indoors)	(hours/day)	6	[1]	6	[1]
Exposure Time (outdoors)	(hours/day)	3	[1]	3	[1]
Exposure Frequency	(days/yr)	182	[1]	182	[1]
Exposure Duration	(years)	4	[1]	4	[1]
Averaging Time (noncancer)	(days)	1,460	[2]	1,460	[2]
Averaging Time (cancer)	(days)	25,550	[2]	25,550	[2]

REFERENCES:

[1] Slosky &Company, Inc. 1989

[2] USEPA 1989

[3] USEPA 1997

[4] USEPA 1991

NOTES:

[a] Table 7-3 (children), mean of male and female. Source: National Center of Health Statistics (NCHS) 1987. 52.5 kg is the average body weight for a child 11-14 years of age.

[b] Table 5-23 - Recommended Values for Inhalation. Short-term inhalation rates for adults involved in light activities.

[c] Table 5-23 - Recommended Values for Inhalation. Mean of short-term inhalation rates for adults involved in moderate and heavy activities.

[d] Assumes soil ingestion rate is the same as the soil ingestion rate of an adult resident.

Table 6. Comparison of Toxicity Values used in the Minturn Middle School Risk Assessment

A. ORAL TOXICITY VALUES

CHEMICAL	1989				2008			
	NONCANCER ORAL RfD (mg/kg-day)		ORAL CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$		NONCANCER ORAL RfD (mg/kg-day)		ORAL CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$	
	Value	Ref	Chronic	Ref	Value	Ref	Chronic	Ref
Arsenic	1.00E-03	[6]	2.00E+00	[6]	3.00E-04	[1]	1.50E+00	[1]
Cadmium	2.90E-04	[6]	--	--	1.00E-03	[1]	--	--
Cobalt	NA	NA	NA	NA	2.00E-02	[4, b]	--	--
Copper	NA	NA	NA	NA	4.00E-02	[2, a]	--	--
Lead	--	[6]	[d]	[6]	--	--	--	--
Manganese	2.20E-01	[6]	--	--	4.67E-02	[1, b]	--	--
Molybdenum	NA	NA	NA	NA	5.00E-03	[1]	--	--
Nickel	2.00E-02	[6]	--	--	2.00E-02	[1]	--	--
Selenium	NA	NA	NA	NA	5.00E-03	[1]	--	--
Thallium	NA	NA	NA	NA	7.00E-05	[5]	--	--
Zinc	NA	NA	NA	NA	3.00E-01	[1]	--	--

NA = Not applicable, Slosky & Company, Inc. (1989) did not quantify risks from this chemical.

-- = A toxicity value is not available for this chemical from USEPA (2003b) recommended sources.

B. INHALATION TOXICITY VALUES

CHEMICAL	1989				2008			
	NONCANCER INHALATION RfD (mg/kg-day)		INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$		NONCANCER INHALATION RfD (mg/kg-day)		INHALATION CANCER SLOPE FACTOR $(mg/kg\text{-}day)^{-1}$	
	Value	Ref	Chronic	Ref	Value	Ref	Chronic	Ref
Arsenic	--	--	5.00E+01	[6]	--	--	1.51E+01	[1]
Cadmium	--	--	6.10E+00	[6]	5.70E-05	[3, a]	6.30E+00	[1]
Cobalt	NA	NA	NA	NA	9.80E+00	[4, a]	5.70E-06	[4, a]
Copper	NA	NA	NA	NA	--	--	--	--
Lead	--	--	--	--	--	--	--	--
Manganese	3.00E-03	[6]	--	--	1.43E-05	[1]	--	--
Molybdenum	--	--	--	--	--	--	--	--
Nickel	--	--	1.19	[6]	--	--	--	--
Selenium	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--

NA = Not applicable, Slosky & Company, Inc. (1989) did not quantify risks from this chemical.

-- = A toxicity value is not available for this chemical from USEPA (2003b) recommended sources.

REFERENCES:

[1] IRIS

[2] HEAST

[3] EPA-NCEA Provisional Value

[4] EPA PPRTV

[5] USEPA Region III RBC Table (11/2007 update)

[6] Slosky & Company, Inc. (1989)

NOTES:

[a] As cited in Region III RBC Tables (11/2007 update).

[b] As cited in Region III RBC Tables (4/2007 update). Value was retired and chemical is currently under review.

[c] RfDo (1.4E-01 mg/kg-day) adjusted by a modifying factor of 3 to evaluate exposure to soil, in accord with IRIS and USEPA Region 8 recommendations.

[d] Slope factors were used to predict potential increases in blood lead concentrations, see Slosky and Company, Inc. (1989) for details.

Table 7.
Comparison of Surface Soil Concentrations at Minturn Middle Soil to RBCs

Chemical	RBC [1] (mg/kg)		Surface Soil Concentration (mg/kg)	
	Concentration	Basis	Maximum[2]	95th UCL [3]
Arsenic	316	NC	196	138
Cadmium	1,053	NC	4.3	3.0
Cobalt	21,058	NC	6.8	8.1
Copper	42,115	NC	15.5	19
Lead	400	[4]	194	NA
Manganese	49,113	NC	643	860
Molybdenum	5,264	NC	1.0	--
Nickel	21,058	NC	14	16
Selenium	5,264	NC	4.5	--
Thallium	74	NC	0.3	--
Zinc	315,865	NC	613	372

-- = A reliable UCL could not be calculated using ProUCL

C = Based on a target cancer risk of 1E-04

NC = Based on a target noncancer HQ of 1.0

RBC = Risk Based Concentration

NA = Not applicable. Exposure to lead is evaluated based on the average concentration in soil; a UCL was not calculated.

UCL = Upper Confidence Limit of the mean

Notes:

[1] Minimum RBC for cancer or noncancer effects, see Attachment 1 for derivation.

[2] Maximum concentration in surface soil reported in Slosky & Company, Inc. (1989).

[3] Derived using USEPA's ProUCL Software verion 4.0 (USEPA 2007), based on surface soil concentrations reported in Slosky & Company, Inc. (1989).

[4] USEPA default RBC for residential land use for a child (0-84 months) exposed to lead in surface soil. This value is assumed to be protective of middle school students 11-14 years old.

ATTACHMENT 1
DERIVATION OF SURFACE SOIL RBCs FOR MINTURN MIDDLE SCHOOL

DERIVATION OF SURFACE SOIL RBCs FOR MINTURN MIDDLE SCHOOL

BASIC RBC EQUATIONS (Ingestion of soil and inhalation of particulates derived from soil):

CANCER:

$$PRG\ (mg/kg) = \frac{TR * BW * AT}{EF * ED * [(IRs * SFo * CF) + (IRa * SFi * PEF)]}$$

NONCANCER:

$$PRG\ (mg/kg) = \frac{THQ * BW * AT}{EF * ED * [(1/RfDo * IRs * CF) + (1/RfDi * IRa * PEF)]}$$

INPUTS:

Parameter	Description	Units	Value
TR	Target Cancer Risk	(unitless)	1.00E-04
THQ	Target NonCancer HQ	(unitless)	1.0E+00
BW	Body Weight	(kg)	52.5
ATc	Averaging Time - Cancer	(days)	25,550
ATnc	Averaging Time - Noncancer	(days)	1,460
EF	Exposure Frequency	(days)	182
ED	Exposure Duration	(years)	4
IRs	Intake Rate of Soil	(mg/day)	100
CF	Conversion Factor	(kg/mg)	1.00E-06
IRa [1, 2]	Intake Rate of Air	(m^3/day)	13.2
PEF	Particulate Emission Factor	(kg/m^3)	8E-10
SFo	Oral Slope Factor	$(mg/kg\text{-}day)^{-1}$	[chemical-specific]
SFi	Inhalation Slope Factor	$(mg/kg\text{-}day)^{-1}$	[chemical-specific]
RfDo	Oral Reference Dose	$(mg/kg\text{-}day)^{-1}$	[chemical-specific]
RfDi	Inhalation Reference Dose	(mg/kg-day)	[chemical-specific]

[1] IRa = [IR_a(indoors) * ET(indoors) + IR_a(outdoors) * ET(outdoors)]

[2] Assumes Cair(indoor) = Cair(outdoor) AND that Cair(outdoor) = Csoil * PEF

CALCULATIONs:

Chemical	CANCER SF $(mg/kg\text{-}day)^{-1}$		NONCANCER RfDs (mg/kg-day)		RBC (mg/kg)		RBC[1] (mg/kg)
	Oral	Inhalation	Oral	Inhalation	Cancer	Noncancer	
Arsenic	1.50E+00	1.51E+01	3.00E-04	--	1.23E+03	3.16E+02	316
Cadmium	--	6.30E+00	1.00E-03	5.70E-05	2.92E+06	1.05E+03	1,053
Cobalt	--	5.70E-06	2.00E-02	9.80E+00	3.23E+12	2.11E+04	21,058
Copper	--	--	4.00E-02	--	--	4.21E+04	42,115
Manganese	--	--	4.67E-02	1.43E-05	--	4.91E+04	49,113
Molybdenum	--	--	5.00E-03	--	--	5.26E+03	5,264
Nickel	--	--	2.00E-02	--	--	2.11E+04	21,058
Selenium	--	--	5.00E-03	--	--	5.26E+03	5,264
Thallium	--	--	7.00E-05	--	--	7.37E+01	74
Zinc	--	--	3.00E-01	--	--	3.16E+05	315,865

-- = A toxicity value is not available for this chemical from USEPA (2003b) recommended sources.

[1] Minimum RBC derived for cancer and noncancer effects.